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A Mixed Pressure Steam Turbine

A 2000-KW. FRASER & CHALMERS TURBINE RUNS AT 3000 R.P.M.

IT IS NOT LONG since the standard speed of a three-phase generator, rated at 2000 kw. was 1500 r.p.m., while for one of 5000 kw. output the limiting speed was 750 r.p.m., a figure which, indeed, was often adopted for 3000-kw. units.

Modern speeds of steam turbines are indicated by noting that 750 r.p.m. is the speed adopted for the 25,000-kw. units at Chicago, generating 25-cycle current. For 50-cycle current turbo generator units up to 25,000 kw. running at 1000 r.p.m. up to 15,000 kw. at 1500 r.p.m., are in successful operation, also 5000 kw. at 3000 r.p.m. These large impulse turbines have been designed in a single casing, single flow. The limit of size is, of course, the same whether the impulse or reaction principle be adopted, and is, in practice, fixed by the loading gage of the railways, which will not admit of the transport of a wheel larger than some 13 ft. in diameter. The advantages of the higher speeds which have of recent years become practicable consist mainly in the greater output obtained for a given weight of a plant.

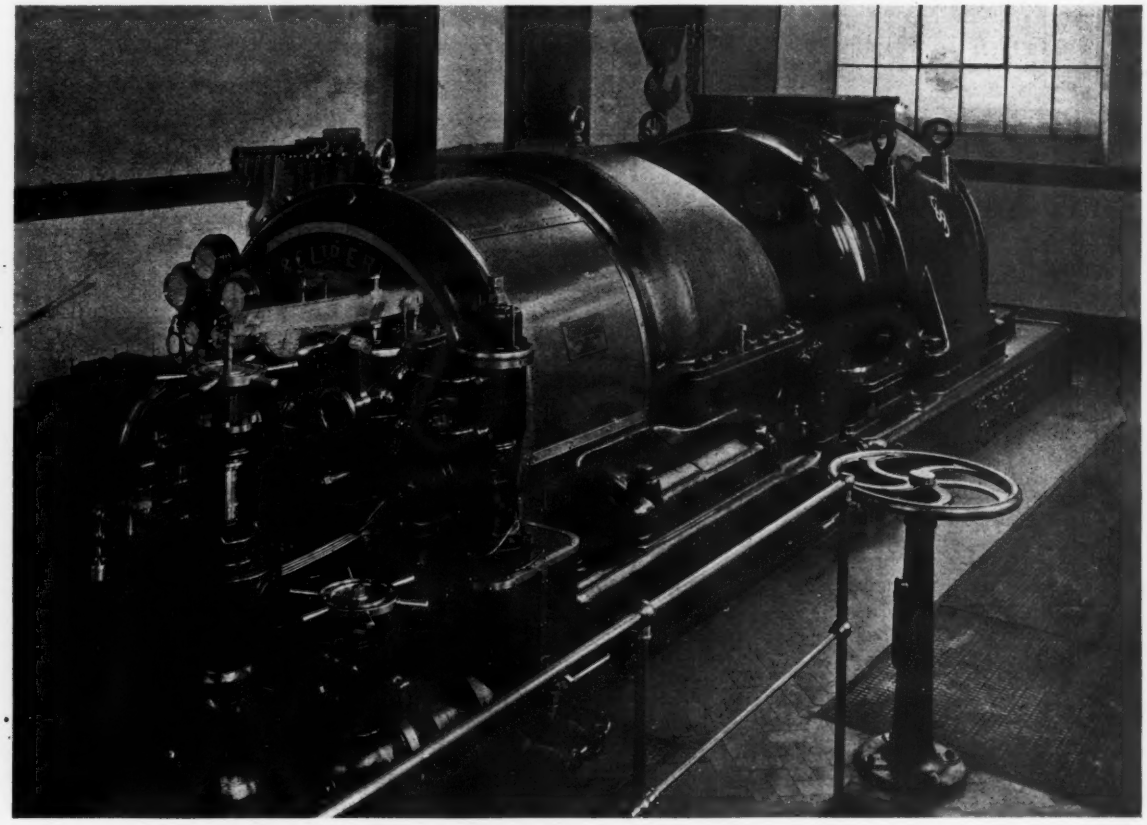


FIG. 1. VIEW OF MIXED PRESSURE TURBINE AT THE BARGOED COLLIERY

The accompanying photograph shows a mixed pressure turbine erected at the Bargoed Colliery of the Powell-Duffryn Steam Coal Company and designed at Enith, Kent, to develop 2000 kw., the speed of rotation being 3000 revolutions per minute. This turbine is giving a load of 2190 kw. with low pressure steam alone, amounting to 71,000 lb. per hour, this output constituting at the time of construction a record for low-pressure steam in a single flow turbine running at 3000 r.p.m.

It is stated that if the essential elements of the low pressure part of this turbine were added to a high pressure turbine designed for the same steam quantity—i.e., 71,000 lb. per hour—the output obtainable would be, with good steam conditions, more than 5000 kw. A section through the 2000-kw. mixed pressure turbine may be noted in the drawing and a comparison of the exhaust end of this with the section through an exhaust steam turbine, demonstrates in a very striking fashion the sweeping character of the changes made. In the new turbine the steam is expanded from about atmospheric pressure down to condenser pressure in four stages, while the older turbines took seven. The mean blade speed at the last stage has, however, been increased from 378 ft. per second in the old pattern to 650 ft. in the new.

This turbine is of the mixed pressure type, being designed to operate either with live steam supplied at a gage pressure of 150 lb. per sq. in. and at a superheat of 100 deg. F., or with low pressure steam at about 15 lb. absolute derived from heat accumulators, or with a combination of the two. With mixed pressure working the following outputs were guaranteed under different conditions. Twenty-five per cent overload was to be obtained with 60,000 lb. of exhaust steam and 11,000 lb. of live steam per hour, or with 40,000 lb. of exhaust steam and 20,500 lb. of live steam or with 30,000 lb. of exhaust steam and 25,700 lb. of live steam, the corresponding vacuums being 28.25 in. and 28.55 in. respectively.

It is of interest to note that full load was to be obtained with 60,000 lb. of exhaust steam and 400 lb. of live steam or with 40,000 lb. of exhaust steam and 13,550 of live steam, or with 30,000 lb. of exhaust steam and 19,000 lb. of live steam, the corresponding vacuum being 28.5 in., 28.6 in. respectively. The normal hourly supply of exhaust steam available at the power station is 60,000 lb. per hour, and the cooling water supply on which the guarantees were based is 3800 gal. per hour at 60 deg. F.

The high-pressure section of the turbine comprises two stages only, the first of which is velocity compounded, the wheel, which is 43 in. in mean diameter, having two rows of buckets. Although this wheel has a smaller mean diameter than the larger wheel at the exhaust end of the turbine, it carries a heavier rim-load and is subject therefore to nearly the same centrifugal stresses. The design is such that these stresses are well below the elastic limit of the material used, which is mild steel.

It will be observed that each blade terminates at its inner end in a fork, which straddles a seat turned for it on the wheel, and to which it is secured by rivets, as indicated. This system of fixing the blades is used throughout the turbine. Each blade is held by two rivets, each rivet holding the forks of two adjoining blades. Each blade is thus held at two points, any shifting being rendered impossible, and yet the number of rivets is equal to the number of blades. For short blades where the centrifugal pull on the fork is small, the forks are also short and the rivets arranged on one pitch circle. Owing to the shortness of the fork, the blade is very light, which is important for high speed wheels with two or more rows of blades. For long blades the fork is made longer and the rivets arranged on two different pitch circles; the sectional area of the fork on one of these pitch circles is reduced by one rivet only, the fork is thus capable of withstanding higher centrifugal pull and can be applied to longer blades.

It is claimed that the particular advantage of these blades is that the sectional area of the fork where a rivet passes through can be made equal to or even larger

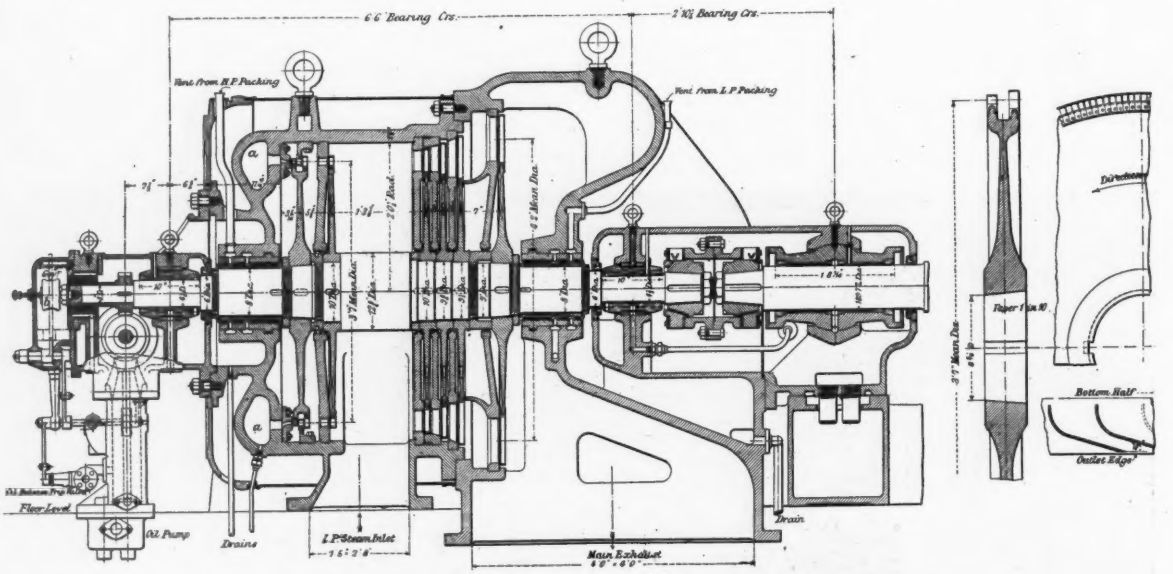


FIG. 2. CROSS SECTION AND DETAIL OF ENGLISH TURBINE

than the sectional area of the blade proper, so that the stresses in the fork are not greater in the blade instead of being much increased, as may happen when made with dovetail roots.

These blades are of such form that an independent shrouding strip is not required, each blade having a lug at its outer end, which fits into the hollow of the succeeding blade. This is the plan adopted when the blades are short, but with long blades an independent shrouding strip is used. The low pressure part of the turbine was designed for 71,000 lb. per hour of low pressure steam, supplied at 15 lb. per sq. in. absolute with this steam quantity there is, in the interspace, between the high pressure and low pressure part, about atmospheric pressure.

It is said that with reduced steam quantity this pressure falls nearly proportionally. When the turbine operates with high pressure steam only, the steam quantity is considerably smaller; therefore the pressure in the interspace will be considerably below atmospheric pressure. When working at full load, with high pressure steam only, the pressure drop in the first stage is from about 150 lb. per sq. in. absolute to about atmospheric pressure; the second stage utilizes the pressure drop down to about half of the atmospheric pressure, the rest being utilized in the low pressure part.

When a supply of low pressure is available, the high pressure supply is automatically throttled by action of the governor, as will be explained in detail later. The last four stages form simply a Rateau exhaust steam turbine. The most noteworthy point is that the wheel at the last stage is 50 in., in mean diameter, corresponding to a mean blade speed of 650 ft. per second. Of these four wheels, all but the last rest on parallel seats on the shaft, and are tightened up one against the other by a single nut. The last wheel of the four is provided with a conical seat, on which it is held by an independent nut. All wheels, after being bladed and balanced, are run up to a speed of 30 per cent in excess of their normal working limit.

This operation is carried out in a steel box, the wheel being mounted on a vertical spindle and spun around by steam jets till it attains the desired velocity. After this operation it is again balanced. Since a 30 per cent increase in speed means an increase of 69 per cent, in the centrifugal stresses, the wheels which have undergone this test should be safe, not merely against bursting, but against the risk of shedding their blades as a consequence of the stresses developed in normal working. The casing of the turbine consists of four castings, combined in two's to form upper and lower half casings which are united at a horizontal joint. The exhaust end of the lower half is rigidly bolted to the bed plate, provision for the expansion of the casing by heat being made at the high-pressure end.

Where it passes through the turbine casing the shaft is packed by means of labyrinth glands and in the case of the gland at the low-pressure end of the turbine, steam at a pressure slightly above that of the atmosphere is admitted to a steam belt near the center, its pressure being adjusted so that a little vapor is always issuing from a leak-off pipe shown. At the high-pressure end steam slightly above atmospheric pressure is similarly admitted to a belt in the gland at partial loads, as then the pressure in the casing is below atmospheric pressure, consequently the separate supply of sealing steam may be cut off. These on the bush are made of brass and are forked, the ends of the fork being brought to a fine edge. Hence, if a touch occurs between them and the steel sleeve protecting the shaft, the fine edges simply rub away, without danger of the shaft being bent by the heat developed by the friction.

There is a small thrust, or rather alinement block fitted at the high-pressure end of the shaft, as indicated in the drawing and the block is of cast iron lined with white metal, which is cast on the previously tinned surface. Forced lubrication is provided and oil under pressure is also used for working the relays which operate the governor valves. The oil-pump, which is of the gear type, is driven by a bevel wheel on the end of the governor spindle.

This Rateau steam turbine was built by Fraser & Chalmers, Ltd.

The Laborers at Home

By John Pierce

WE'RE the strength of the starry banner that's flung to the azure sky,
We are the might of the nation's fight, 'tis ours to do or die.
We tend the wheels of the country, with never a stop or pause,
And though we strain with all our main, we ask for no applause.

We hear no sound of bugle, we bury no gloried dead;
But from shore to shore where oceans roar, from the lakes to the gulf's wide bed,
We'll back the lads who march away to lands across the sea,
And, put to the test, let us do our best—just fellows like you and me.

We are the heart of the nation, we engineers here at home,
Who labor at length with all our strength for those o'er the salt sea's foam.
As in peace we've done our duty, so in war will be duty's slave,
And the wheels shall hum like the warrior's drum, that freedom's flag may wave.

We are the army of labor, ready to prove our worth.
We have the will, we match the skill of the best trained troops on earth,
And we'll play the game to the limit, nor murmur at any fate,
For we're the clan of Uncle Sam, who sails the ship of state.

Then it's ours to bear our burdens—to work 'till the victory's won,
Though no service stars or silvered bars shall honor the service done.
For dear ones and for home land, our bit lies clear to do,
To back the flag and never lag, and prove we're loyal true.

Joliet Plant of the Public Service Co.

THE LATEST POWER PLANT IN A CHAIN WHICH SERVES NORTHERN ILLINOIS, SUPPLIES STEAM TO TURBINES AT 300 LB. PRESSURE AND 225 DEG. SUPERHEAT. OTHER FEATURES ALSO INDICATE CHANGES IN MODERN PRACTICE

THE TENDENCY TOWARDS tying together the electric generating power plants serving the public in an extended district is as marked in the neighborhood of Chicago as in any other community in the country. This is largely the direct results of the efforts of the Public Service Co. of Northern Illinois to cover the district with a net work of transmission and distributing lines supplied with current from large plants advantageously located within the district. Many plants have been purchased and improved or discarded as condition directed, all with the idea of serving the public with an unfailing power at a cost otherwise unattainable.

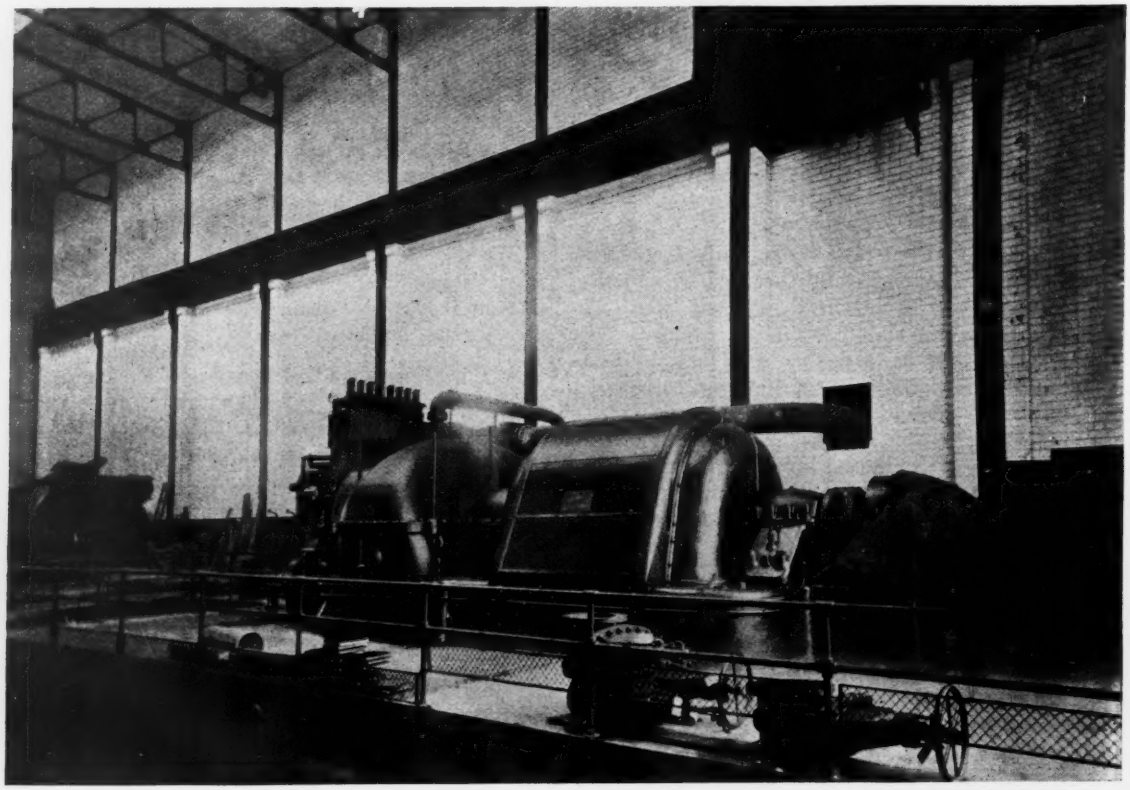


FIG. 1. VIEW IN TURBINE ROOM OF JOLIET PLANT SHOWING SECOND UNIT UNDER CONSTRUCTION

One of the most important recent projects of this company is the building of a 20,000-kw. plant, with provisions for enlargement, near the city of Joliet, which will tie in with the company's other plants. While still in the course of construction, part of the plant is in operation and although some of the contemplated refinements of the plant are at present lacking, the following description will give the reader an idea of the most important features of the plant.

Station No. 9, as it is called, is located about 4 mi. southwest of Joliet on the Chicago & Alton and the Atchison, Topeka & Santa Fe railways, and adjacent to the Des Plaines River. The location is therefore advantageous for supplying coal and condensing water.

Coal comes from Illinois and Indiana mines to the station in cars and may be unloaded into the plant immediately or into the coal yard where there is space for the storage of a 60-days' supply. This coal yard has five railway tracks running parallel to each other with connecting switches, four of these pass through the basement of the plant. The tracks are at such distance apart as to give access to the entire yard by means of a locomotive crane and grab bucket which is used to unload coal desired for storage and to load it upon cars when it is to be hauled into the plant. Switching of the cars is done by the company's own locomotive.

In the basement under the boiler room are three railway tracks upon which cars can be run from either end of the building, the doors being of the rolling steel type. At present there is room for only one car on each track but as the station is enlarged this space will also be increased. On the center track designated as No. 3 coal cars are handled. This is under the firing aisle. The other two tracks, Nos. 2 and 4, are directly under the ash pits of the two rows of boilers.

Coal brought into the plant is usually unloaded by means of a 10-ton Whiting traveling crane equipped with a 2-yd. grab bucket into a four-roll Orton & Steinbrenner

traveling coal crusher which discharges into the Link-Belt bucket elevator and conveyor or to the 800-ton concrete storage pit beneath from which it may be taken by the grab bucket and delivered to the conveyor.

Coal coming to the plant in dump cars that are not easily unloaded by the grab bucket are dumped into the storage pit direct and handled from there by the grab bucket crane.

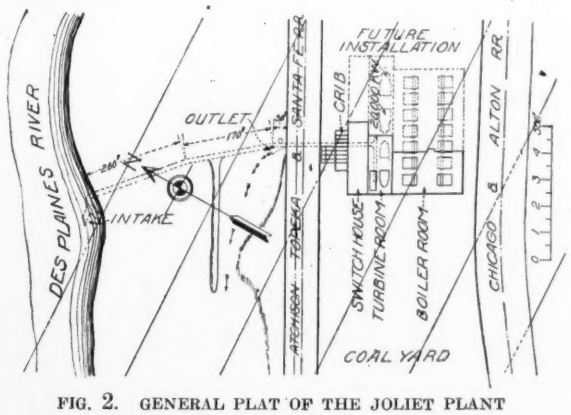


FIG. 2. GENERAL PLAT OF THE JOLIET PLANT

Ashes that come over the end of the grates are immediately sprayed with cold water which prevents the formation of large clinker in the ash pit. The latter is brick lined and fitted with a gate through which the ash is dumped direct to the car on the track beneath. Unburned coal and coke which falls through the fore part of the grate is directed by chutes to the coal pit from which it again goes with the green coal through the coal handling system to the boiler furnaces.

lift is 73 ft. and the horizontal run 66 ft. but the equipment is designed for an ultimate horizontal run of 230 ft. and is, therefore, made heavier than required for the present needs. A 50-hp. G.E. motor drives the conveyor and is located at the top of the ascending vertical run.

Coal will be weighed on the company's own railway scales as it is delivered to the plant. These scales have not as yet been installed but provisions have been made for them. An elaborate station laboratory is also being fitted up for the testing of coals, ash, flue gases, oils, etc., which will aid in securing higher economy.

Boilers

The present steam generating equipment consists of three boilers with the fourth under course of erection. These are Babcock & Wilcox cross drum boilers each having a heating surface of 9919 sq. ft. and built for a working pressure of 350 lb. The superheater is of the built-in type having 3100 sq. ft. of surface and increases the temperature of the steam 225 deg. F. Each boiler has 429 4-in. tubes 20 ft. long, the arrangement being 33 wide and 13 high. The drum is 160 in. in diameter by 23 ft. 10 in. long made up of open hearth steel 1⅜ in. thick with a tensile strength of 56,000 lb. per sq. in.

Flue gases, after leaving the boiler, pass through an economizer of the Babcock & Wilcox Co. design.

The economizer is built in the same setting with the boiler, forming in reality a part of it without a damper between, and resembles a B. & W. boiler without a drum having 396 tubes set at a slope of 5 deg. and two baffles resulting in three passes of the gases. The headers are of wrought steel and the tubes of drawn steel ¼ in. thick,

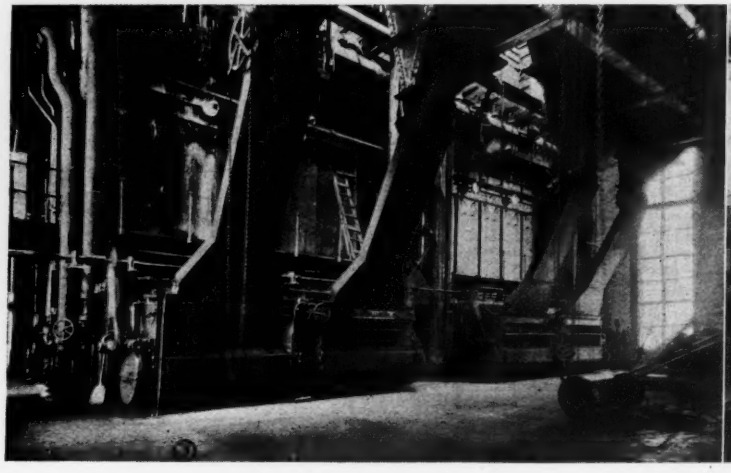


FIG. 3. VIEW IN THE BOILER ROOM

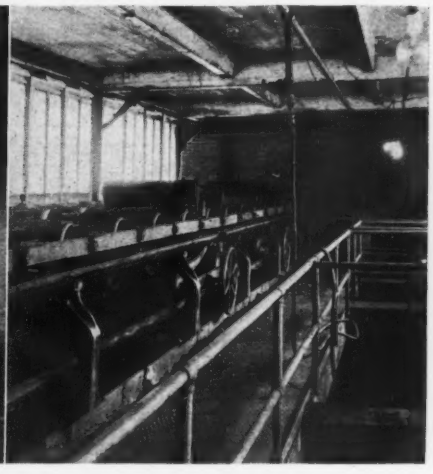


FIG. 4. UPPER RUN OF THE COAL CONVEYOR

From the basement, the coal is elevated and dumped into a bunker directly over the firing aisle from which a coal chute leads to each stoker, a valve operated by a chain from the floor being used to cut off the supply when this is desirable. The total capacity of the bunker is 450 tons or 112 tons per boiler. The coal conveyor has buckets 36 in. long carried on forged steel links with 30-in. centers. The travel is normally 45 ft. p.m. giving a rated capacity of 120 tons per hr. The vertical

4 in. in diameter and 16 ft. long galvanized inside and out to prevent corrosion, this being practical by reason of the low temperature expected. The total heating surface of each economizer is 6730 sq. ft.

Each boiler has its individual unlined steel stack, 7 ft. in diameter and 65 ft. high above its foundation of eye-beams over the economizer, the height above the grates is 125 ft. Between the economizer and the stack is a double-suction, motor driven Sturtevant multivane

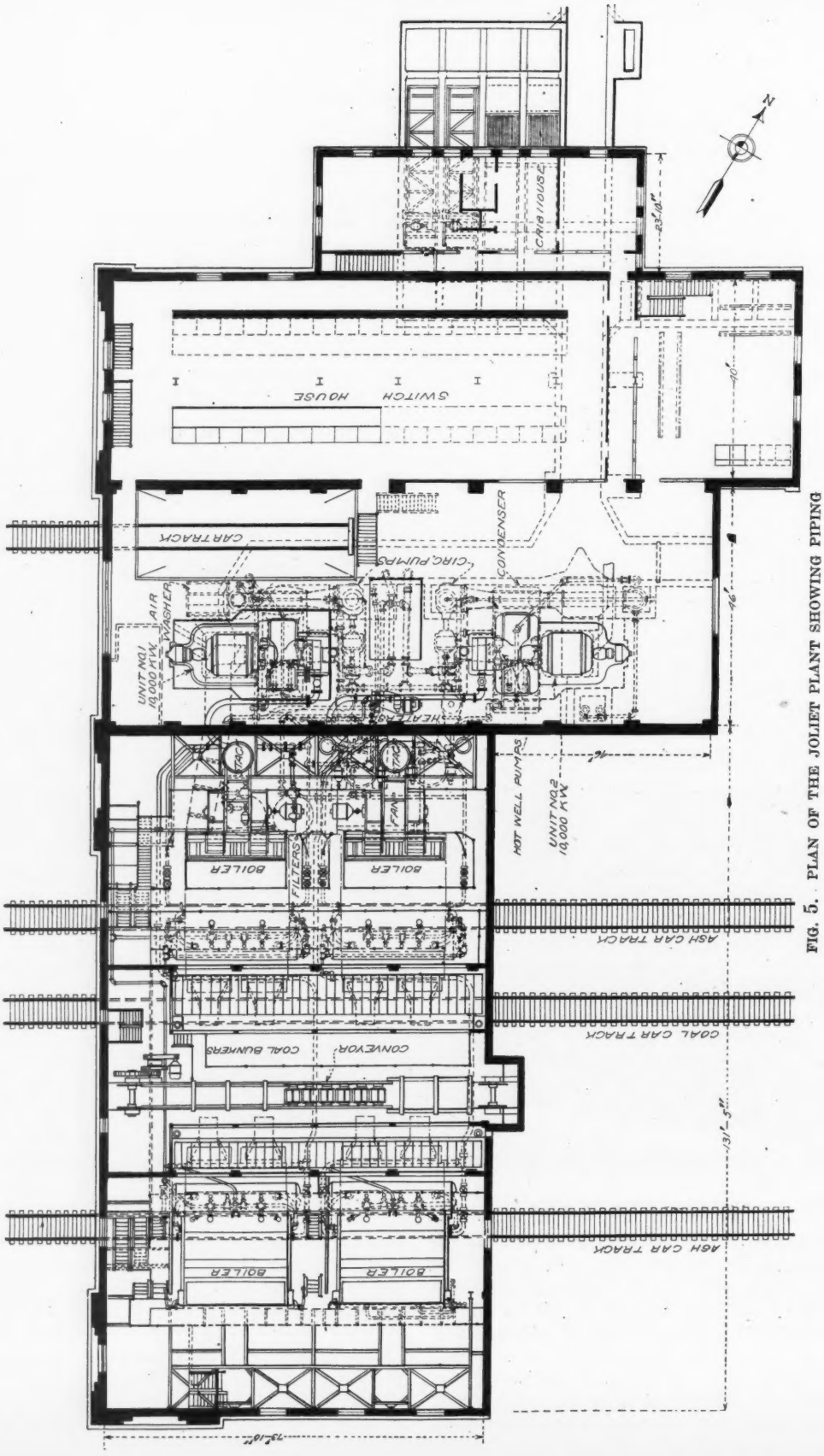


FIG. 5. PLAN OF THE JOLIET PLANT SHOWING PIPING

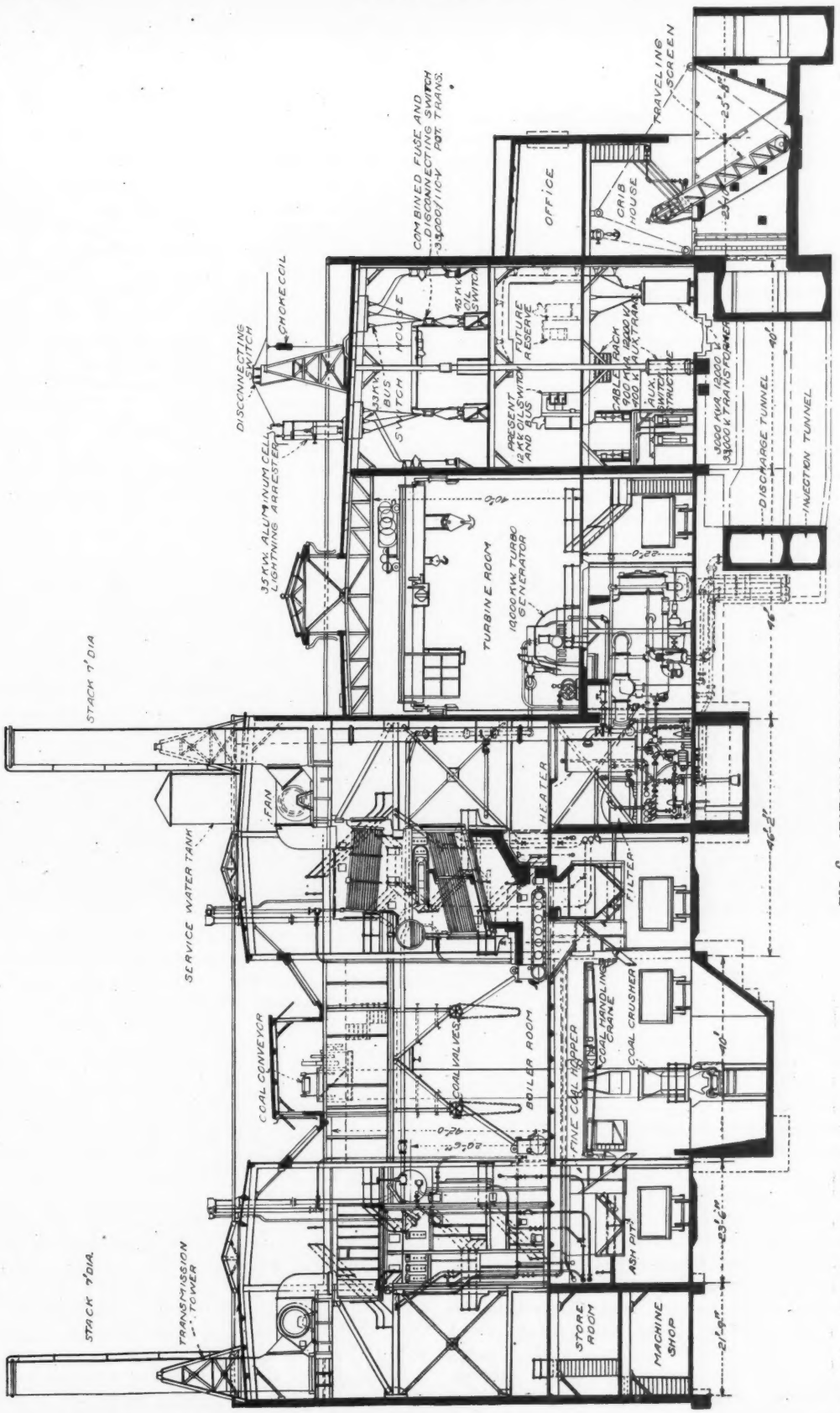


FIG. 6. SECTIONAL ELEVATION THROUGH PLANT

induced draft fan with a capacity of 75,000 cu. ft. per min., which maintains a draft in the furnace, indicated by a Hays differential draft gage. The motor is direct connected to the fan and runs at 500 r.p.m. It is rated at 150 hp. taking three-phase current at 440-v. and was supplied by the General Electric Co. The gas handled has a temperature of about 350 deg., as shown by a recording thermometer, and this condition led to the use of water cooled bearings.

Each boiler is equipped with two chain grate stokers placed side by side in the same furnace setting with a partition between them, each stoker having its own ignition arch which is of the sprung type. Each stoker has a grate surface of 96 in. by 174 in. Stokers are driven in the usual way by eccentrics and rods from line shafts which normally receive their power from 10 hp. back geared G.E. motors, operating at 720 r.p.m. Troy vertical engines act as reserve.

Tube surfaces are blown by a hand steam lance inserted through hand doors at the sides of the setting. Doors are provided at the back of the settings through which the lower rows of tubes may be cleaned of clinker forming material while the boiler is in operation.

Mounted on the boiler are four 4-in. Ashcroft pop safety valves, on the superheater are two 3-in. and on

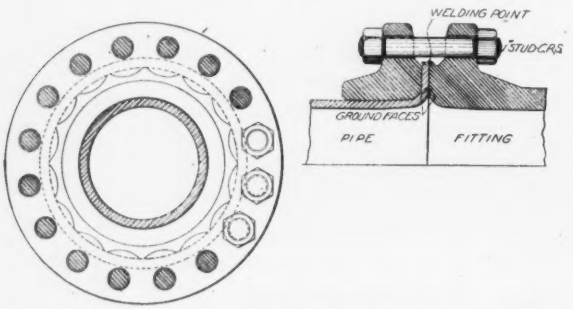


FIG. 7. DETAIL OF HIGH PRESSURE WELDED PIPE JOINT

the economizer are two 2½-in. relief valves. A steam flow meter will be installed on each boiler.

Water Supply

Drinking water is piped to the plant from a nearby spring and distributed to fountains located at convenient places about the plant. Water for general use in the plant except that for drinking comes from the Des Plaines River; that used for all purposes except condensing is pumped from the intake tunnel through the quartz filters to a service tank on the roof which supplies water directly into the piping system for cooling transformers and other services where raw water can be used. The filtering system consists of two pressure filters each of 150 g.p.m. capacity. Filtered water is used for cooling bearings, lavatories and other general purposes, also maintaining a constant level in the sweet water tank under the pump room floor to which is also delivered drips from the piping system.

Make-up feed water is drawn from this well to the lower part of the condenser by the vacuum maintained there; here it mingles with the condensate which is removed by the condensate pump and forced through preliminary heating coils in the upper part of the condenser (where the temperature is raised to nearly that of the exhaust steam from the turbine), on its way to an open feed-water heater. In the heater is a float connected by proper link and lever motion to the valve controlling the make-up water admitted to the vacuum space in the condenser.

The plant will have two Webster feed-water heaters, one for each turbine unit. Each of these has a capacity of 150,000 lb. per hr., using the exhaust steam from the auxiliary turbines and when necessary taking steam under thermostatic control from the fourth stage of the turbine to keep up the desired temperature. For each heater two boiler feed pumps are provided; these are No. 3 Worthington centrifugal pumps of 300 g.p.m. capacity, direct connected to Westinghouse turbines and run at 2500 r.p.m. The pumps deliver the water to the boilers through a duplex piping system, that is, there are two courses through which the water may be directed to the boilers.

Two service pumps are provided, each having a capacity of 600 gal. per min. and run at 1170 r.p.m. Both are Worthington centrifugal pumps, one driven by a Westinghouse turbine, the other by a Westinghouse induction motor rated at 35 hp.

Steam Piping

Due to the high steam pressure carried and the temperature to which the steam is heated, about 650 deg. F., the piping system is one of the most important features of the plant. Throughout the plant the material used for all high-pressure steam piping is extra heavy steel with flanged joints of welded cast steel on all pipes over 4 in. in diameter. As will be noted by the illustration, the weld merely prevents leakage while the strain is taken by the flange and bolts. The valves are also of cast steel, gate valves being the product of the Crane Co., while the globe valves were made by the Edward Valve & Mfg. Co., as were also the automatic stop and check valves in the boiler leads. Several of the principal valves in the headers and leads to the turbine are of the by-pass gate type, operated by hydraulic pressure.

In the piping design, ample provision for expansion and contraction was made by employing expansion bends. Several special pipe bearing designs are also employed in this plant. Insulating covering for the steam piping consists of magnesia and asbestos.

Turbines

When present plans are completed, the plant will have two 10,000-kw. Curtis turbines as the electric generating equipment; only one of these, however, has been put into operation. The turbine is of the horizontal Curtis type, and runs at 1800 r.p.m. under 300 lb. steam pressure and 225 deg. F. superheat. Three-phase current is generated at 12,000 v., 60 cycles and the turbine is rated at 602 amp. per terminal at a power factor of 0.8. Excitation is furnished by a direct current generator with a rating of 400 amp. at 250 v., mounted at the end of the main generator shaft. Separate excitation may be supplied by a turbine driven d.c. unit rated at 100 kw. This exciter generator is driven through a gear by a G.E. turbine running at 3600 r.p.m.

A complete system of signaling between the turbine operator and the switchboard attendant is a feature which is of great aid to the operators. By means of this

system with duplicate indicators at the benchboard and the turbine, the following instructions and replies can be communicated: Start, Stop, Field on, Load, Field off, O.K., Load off, Assistance wanted. The gage board at the turbine has instruments indicating steam, feed water and service water pressures and two recording gages.

The turbine governor is motor controlled from the bench board to enable the operator to transfer load from one unit to another. Air for cooling the generator is drawn through a Carrier air conditioning apparatus by means of which the air is washed and brought to the proper humidity before entering the generator. The warmed air upon leaving the generator may be discharged to the boiler room basement from where it finds its way to the boiler furnaces, or it may be discharged into the turbine room during cold weather to make it more comfortable for the attendants.

The condenser, which is of the Westinghouse surface type, is located directly beneath the turbine, supported on four sets of coil springs which relieve expansion strains. The condenser has 20,000 sq. ft. of condensing surface made up of 1-in. tubes arranged for two passes of the water. One of the special features is the set of preheating coils at the top of the condenser, aggregating 1000 sq. ft of surface, through which the condensate and make-up water passes on its way to the open heater.

The circulating and air pumps are direct connected to one motor, the capacity of which is 200 hp. and its speed 700 r.p.m. The circulating pump is of the double suction centrifugal type designed to handle 18,000 g.p.m. The air pump is of the Westinghouse-Leblanc type, while the condensate pumps, of which there are two for each unit, have a capacity of 360 g.p.m. and are driven by 25 hp. motors.

Circulating water comes to the plant through a concrete tunnel 570 ft. long with a cross-section 10 by 8 ft. from the river to the Santa Fe track, then 8 by 8 ft. to the turbine location, and returns to the river through another tunnel of like dimensions placed directly above the intake but extending only to a swampy section of the river bottoms. Part of this water may be led to the mouth of the intake to prevent freezing in cold weather. A stationary rack is placed across the tunnel at the entrance to the plant to intercept the large share of the floating debris. Behind the rack are two Link-Belt traveling water screens which effectually remove all remaining floating particles that would cause trouble in the condenser. The screens are placed side by side, each being 60 in. wide and run on 27 ft. centers at a speed of 9 ft. per m. A 5-hp. motor drives each screen and means are provided for raising them to a horizontal position for cleaning. Behind these are double sets of stationary screens with ½-in. mesh to catch fibrous matter and small fish.

Lubricating oil for the turbine is circulated by means of a pump from a tank under the base of the turbine. When the oil in the circulating system becomes dirty it is replaced by clean oil and passed through a filtering system.

For handling machinery parts during erection and repairs, a 75-ton Whiting traveling crane is provided in the turbine room which has access not only to the turbine floor but to the basement through hatchways. On the basement floor a railway track is laid for convenience in handling shipments of heavy machinery and materials.

Drips from pumps, condenser wash water and such wastes drain to a sump pit from which they are pumped by a Yeomans Bros. Co. duplex sewage ejector consisting of two 5-hp. vertical motors driving centrifugal pumps at 850 r.p.m. and discharging into the outlet tunnel to the river. Two of these sets are installed.

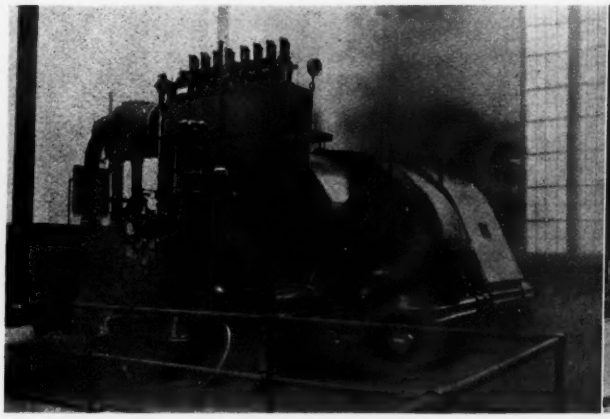


FIG. 8. GOVERNOR END OF TURBINE UNIT

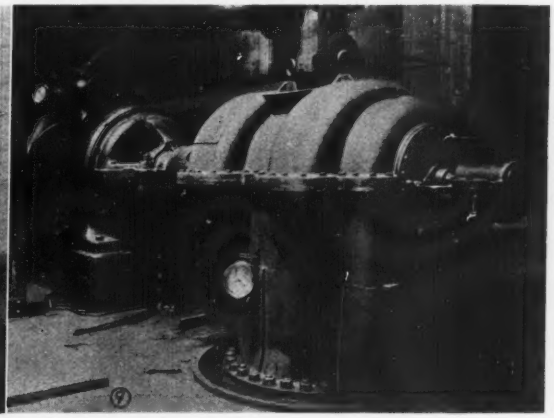


FIG. 9. MOTOR DRIVEN CIRCULATING WATER AND LEBLANC AIR PUMPS SERVING CONDENSER

Compressed air for cleaning purposes is supplied by a motor driven, single stage, air compressor made by the National Brake & Electric Co. It delivers air at 90 lb. pressure and has a rating of 75 cu. ft. per min.

Electrical Equipment

Control of all electric circuits, except those distributing current to motors and lights about the plant, is accomplished from the switchboard room by means of remote control switches operated on the 125-v. circuit of a storage battery. The switchboards have, roughly, a hollow square arrangement which puts all instruments and signal lights in plain view of the operator at all times.

For control of the generator circuits and the exciter a benchboard is employed made up of one panel for each generator, and one for the exciter. Among the instruments on the generator panels are ammeters, one for each phase, two wattmeters for each machine, a voltmeter, a wattless indicator, a meter indicating the temperature of the generator coils and a double throw switch for controlling the turbine governor. On the benchboard is also the signalling device previously described in connection with the turbines. On a pedestal to the right of the benchboard are mounted a voltmeter, a frequency meter and a synchroscope.

Other noteworthy features of the switchboard are: An annunciator alarm to tell when a line switch goes out; this is in addition to the signal light on the switch.

The panels controlling the 33,000 v. lines and those for the 12,00 v. circuits are separate. Each board has a miniature bus on the front to indicate switch connections. A double set of buses is provided for these circuits so that in case one bus should fail the load can be shifted to the other without causing a serious interruption. All switches have interlocking devices to prevent trouble due to throwing the wrong switch. These panels have a full quota of instruments consisting of ammeters, voltmeters and wattless kv.a. or reactive component meters. The relays are mounted on panels directly back of the switch and meter panels for their respective circuits. A water flow indicator shows whether or not the cooling water is running in the transformers.

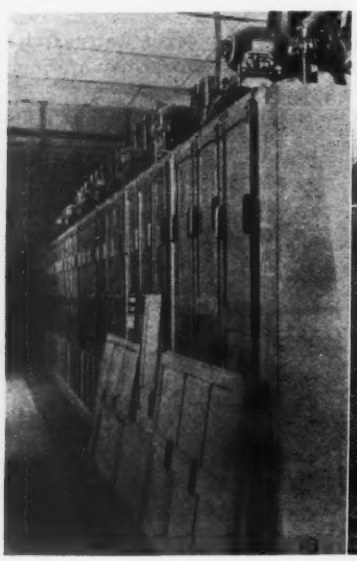
The storage battery switchboard consists of four panels. The feature of particular interest about this board is an automatic switch which throws the lights of the station on the battery in case there is a momentary shutdown of the plant.

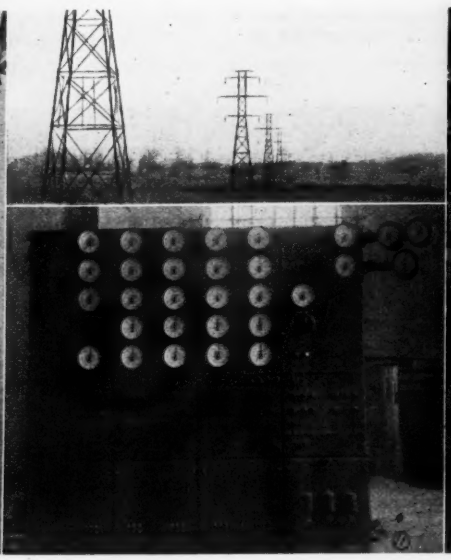
Direct current for charging the storage batteries is supplied by a Westinghouse motor generator set consisting of a 23-hp. induction motor run at 1740 r.p.m. on current at 440-v.; the generator is rated at 15-kw. and 175-v.

The battery was furnished by the Electric Storage Battery Co., and has a capacity or 320 amp.-hr. It is charged at 40 amp., the voltage ranging from 125 to 160.

As previously stated, current is generated at 12,000 volts. Part of the plant output is transmitted direct to the company's network of transmission lines over lines carrying 12,000 v. while the rest of the load is transmitted at 33,000 v. over three lines at present, with three more contemplated. That current used about the plant is transformed down to 440 v. at which it is distributed through hand operated switchboards to the various motors of the plant. The lighting circuits are on the three-wire plan, 220-110 v.

The power transformers are located in the basement under the bus bar compartment. The present equipment consists of three 3000-kv.a., single phase, water cooled, Westinghouse transformers with a voltage ratio of 12,000 to 33,000, and two 900-kv.a. three-phase transformers with a voltage ratio of 12,000 to 480.





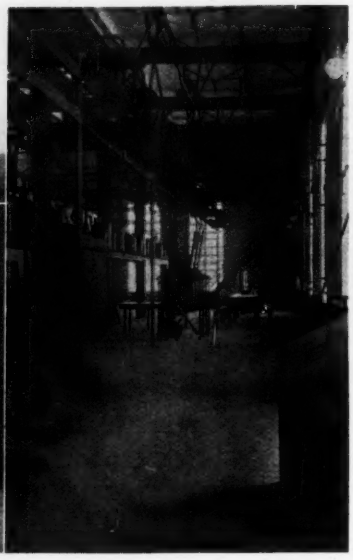


FIG. 10. 12,000-V. SWITCH COMPARTMENTS. FIG. 11. SWITCHBOARD FOR REMOTE CONTROL OF 33,000-V. SWITCHES FIG. 12. 33,000-V. SWITCHES AND BUS STRUCTURE

Directly above the transformers on the main and second floors are respectively the 12,000 and 33,000-v. switches and bus constructions. The 12,000 switches are all inclosed in vertical cells with the bus bars in horizontal compartments directly behind the switches. The wiring here is all of bare copper with bus bars of the strap shape. The switches are of the oil type operated by motors placed above them as shown in one of the accompanying views. Two rows of these switches are installed, placed back to back with a wide aisle between them which arrangement gives the switchboard operator a full view of this entire room.

Buses for the 33,000-volt circuits are insulated copper tubing and the construction work is of the open type.

Protection against lightning is afforded by electro-

lytic lightning arresters furnished by the General Electric Co. These are located on the roof and are provided with both horn and ball gaps.

Officers of the company who have directed the work of this plant are: Samuel Insull, president; Frank J. Baker, vice-president in charge of operation and construction; George H. Lukes, general superintendent; and J. L. Hecht, mechanical engineer. Sargent & Lundy, consulting engineers, designed the plant and Von Holst & Fyfe were employed as architects.

Storage of Bituminous Coal

AS experiences of the present winter drive home the desirability of accumulating during the coming summer a reserve of coal against next season's emergencies, the question of loss in heating value by storing coal becomes important; also the matter of danger of fire in the storage piles.

Extensive work has been done by the University of Illinois and the U. S. Bureau of Mines in gathering information, some of the results being given herewith.

Illinois Coals

Carload lots were stored for 6 yr. at the University of Illinois, and lots of 100 to 200 lb. under water for 1 yr. heat values of the coal being tested on mining after a week in storage, and at intervals of 2, 6 and 12 mo., and 3 and 6 yr. At the end of the 6-yr. period, boiler tests were made with the stored coal.

When freshly mined, coal takes up oxygen from the air rapidly, with generation of a little heat, but at the end of 5 mo. this absorption ceases. Franklin County coal took up some 0.8 per cent of its own weight, and the temperature rose 1.5 to 2.25 deg. F. Pyrite in the coal if finely divided, and with moisture present, tends to increase the rise in temperature, and, if the temperature rises above 180 deg. F. may result in spontaneous combustion.

Heat value of the coal diminishes most rapidly during the first week, the average loss being 1 per cent. An additional loss of 2 to 3 per cent may occur during the first year; after that the rate of loss decreases gradually, the total loss for 6 yr. being in some cases 11 per cent, due to escape of gases, oxidation of coal and increase in weight of organic matter.

Loss from the first cause is so small as to be negligible; from the second cause is of small consequence as to the heating value, but may be the cause of heating in the storage pile; and from the third cause is more apparent than real, since heat is not lost, but material is added by as much as 3 per cent making the heat per pound of final weight less.

Coal stored in open bins shows a less percentage of loss than that stored under cover, though the increase in weight is greater under covered storage.

Slacking

Disintegration, or increase in the slack by breaking down of lumps is of importance, and tests on size were made at the time of storing, after 18 mo. and after 6 yr. Fine material was taken as all that would pass through a ¼-in. mesh screen and the per cent of increase after 18 mo. was 11 to 17, and after 6 yr. 12 to 31, the averages being 13.25 and 22, respectively. Removal of the storage piles by wagon at the end of the third year involved a double handling which, no doubt, increased the amount of fine material.

It is also thought that oxidation of the organic matter and the pyrite sulphur is largely responsible for the breaking down of the lumps.

Boiler Tests

Weathered coal did not burn as freely as freshly mined, hence required a stronger draft, which accounts for the impression that the weathered coal has a less heat value, since for a given draft the rate of combustion will be less. With correct handling and ignition the weathered coal gave as good results as fresh, both in boiler horsepower developed and efficiency.

Chain grates were used, and it was found that the weathered coal needed a thinner fire bed and more draft than fresh; also that the coal must be kept 4 to 6 in. away from the water back or clinker resulted. If anything, the fuel bed requires less attention with weathered coal than with fresh.

Results of the tests give the following facts as to Illinois and similar coals. Heat loss is negligible if ventilation or radiating surface is provided so that the temperature does not rise above 180 deg. F. Lump only can be stored more safely than slack or run of mine. Under-water storage reduces heat loss and slacking to a minimum.

Bureau of Mines Tests

Coal used was New River from Fayette Co., West Va., and was stored at Portsmouth, N. H., Norfolk, Va., Key West, Fla., and Pittsburgh, Pa. Barrel lots of 300 to 350 lb. were used as samples. Tests were made on ¼-in. coal and run of mine, under-water, dry indoors and piled outdoors. At Pittsburgh, fresh water was used, and at the other stations salt water, for underwater tests.

The tests were for 1, 2 and 5 yr. and showed greater loss in the warmer climates than in the colder. At Key West, the loss for outdoor piles of ¼-in. coal was 1.2 per cent after 1 yr. and 2.1 after 2 yr., which was 50 to 100 per cent larger than loss of the run of mine.

Submerged samples showed practically no loss after 1 yr., 0.2 to 0.6 per cent after 2 yr. and 0.5 average after 5 yr.. Outdoor samples showed continuous slight decrease, the Key West samples having a maximum of 2.6 per cent after 2 yr. and after 5 yr. 1.4 per cent at Portsmouth, 1.7 per cent at Pittsburgh and 1.3 per cent at Norfolk. Experimental error was probably 0.2 to 0.4 per cent, so that the losses might have been less or greater by these amounts.

No screen tests of slacking were made, but the samples at Pittsburgh showed no change that was observable by inspection.

No difference was found in the loss in submerged samples with fresh or salt water, but alternate drying and submergence showed a slight though unimportant loss.

Other tests were made of Pittsburgh coal in open and submerged storage showing negligible loss in 1 yr. even in the upper 6 in., and not over 1.1 per cent in 5 yr. for open storage, and no loss for submerged storage.

Pocahontas, stored on the Isthmus of Panama in the open, showed a heat loss of less than 0.4 per cent in a year, all during the first 6 mo.; and a further loss of 0.4 per cent during the second year.

Sheridan, Wyo., sub-bituminous coal showed losses of 3 to 5.5 per cent in 3 yr., 75 per cent of this being in 9 mo. Deep bins suffered more than shallow, probably because the sides gave greater access for the air. A layer of slack 12 in. thick formed on top and protected the surface from further oxidation. Tight sides and bottoms to bins are, therefore, more important than roofs for this class of coal. Piles more than 10 ft. deep or wide should not be used on account of danger from heating.

Hints on Storage

As a result of these tests, the Bureau of Mines offers the following hints in regard to storage of any bituminous coal:

1. Piles not to be over 12 ft. deep, and no part of the interior to be over 10 ft. from the surface.
2. Store only screened lump coal—if possible.
3. Keep out dust as much as possible, and to do this avoid handling.
4. Have lump and fine evenly distributed. Do not let lumps roll to the bottom and form air passages.
5. Rehandle the screenings after 2 mo., if possible.
6. Store away from any sources of even moderate heat, and well away from the main buildings of the plant; *never* against a frame building.
7. Allow 6 weeks seasoning after mining before putting into storage piles.
8. Avoid alternate wetting and drying.
9. Avoid admission of air to the interior of the pile through interstices around timbers, irregular brick work or a porous bottom such as coarse cinders.

If wet coal is received, dump in small piles or around the edges, where air can get to it freely to carry away moisture, and where other coal will not be packed on top of it.

Steam Turbine Hints

BLADE stripping is now infrequent, as operation is better understood than formerly; but a partial stripping in the high-pressure end may occur without any external sign. One indication of such condition is a lower steam chest pressure at all loads, and such an indication should cause an investigation of the blading.

If expansion is not properly allowed for, it may result in wearing of the blade ends or the shroud ring on the ends of the blades, resulting in increased steam consumption because of the increased radial clearance. The remedy is new blading or a new shroud ring, and the removal of the cause of the wear.

Another source of steam leakage is wear of the dummy pistons. It does not show except in the coal burned, and can be detected only by careful measurement of actual clearances around the pistons. The remedy is readjustment of the packing and labyrinth rings.

Steam is not supposed to carry solid matter; but it doesn't always play according to that rule, and sometimes an incrustation will be found, especially in the low-pressure blading, even sufficient nearly to choke the passages between blades. This will be shown by a falling off in power developed, and an increase in steam consumption. Cleaning the blades is the remedy, but the condition can be prevented by treating the feed water to remove mineral matter and frequent blowing down.

Vacuum is, of course, important, as the steam demand of a turbine is rapidly increased by falling off in vacuum. When any such falling off is indicated by the gage, hunt for air leakage in joints of piping and condenser and around the turbine shaft at the low-pressure end; for air-pump trouble; for choked condenser tubes; for small supply or high temperature of cooling water.

Choked tubes may be cleared by circulating dilute hydrochloric acid through the water space for 2 or 3 hr. by means of a small pump, blanking the condenser off from the circulating pump and piping. Or the tubes may be cleaned by special condenser tube cleaners.

Coal Can Be Saved

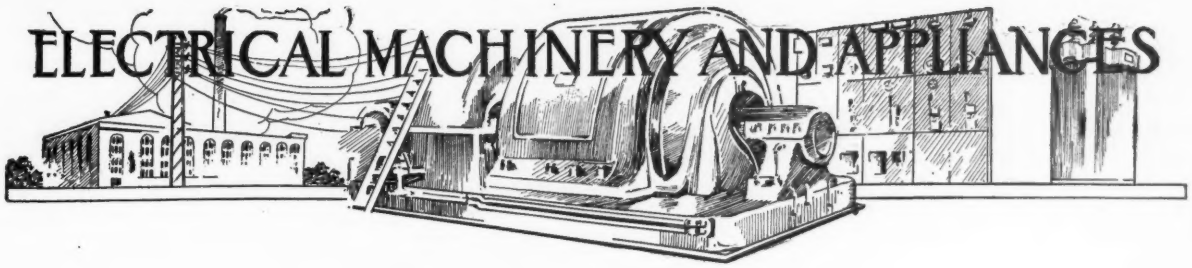
In a discussion at the annual meeting of the A. S. M. E. on Preventing Coal Waste, some speakers advocated government control by restricting coal supply of those plants which could not prove that they were using fuel economically. Many, however, thought the better plan to be giving the best possible instruction as to proper methods of burning coal and striving for voluntary cooperation, at any rate as a first step.

A. F. Graves stated that as a result of installing an instrument board with water and steam flow meters, temperature recorders and draft gages; then running a series of tests to determine most efficient operating conditions at all loads and issuing instructions so that these conditions could always be maintained, a saving of about 12 per cent of the coal was made.

Use of peat, low grade coal, and mining to avoid waste at the mines were advocated as possible means of increasing fuel supply.

Edward N. Trump told of the raising of efficiency in their boiler plants from 50 per cent average to 85 per cent, largely by giving a bonus to the firemen so that it was to their interest to save coal. At least 10 per cent saving can be made in almost any plant by using such a plan. The values measured were carbonic acid in the flue gases, water fed to boilers and carbon in the ashes. From these the efficiency can be determined and a suitable reward offered for improvement and maintaining the improved efficiency.

D. M. Myers said that 50,000,000 to 100,000,000 tons of coal can be saved a year by improved methods. A saving of 10 to 25 per cent can be made by better operation, and the bonus system, properly suited to the conditions of a plant has proved effective. Every plant in the country burning as much as 5 tons a day should have an accounting system to keep track of the efficiency of furnaces and boilers. The best system is continuous record of coal and water by modern methods, with a check on performance by flue gas analysis. If coal and water cannot be measured, the gas analysis will give a valuable indication of the efficiency of the plant.



Testing Watthour Meters

METHODS AND SCHEMES OF CONNECTIONS EMPLOYED. BY R. L. MOSSMAN

THE accompanying diagrams show the scheme of connections which may be employed for testing single-phase two-wire, single-phase three-wire and three-phase three-wire watthour meters, using a single-phase rotating standard test meter, or a single-phase indicating wattmeter as a master instrument. In these diagrams the service meter under test is represented by dotted lines; P is the potential coil; S is the series or current coils.

Figure 1 shows the necessary connections when testing a single-phase two-wire watthour meter with a rotating standard test meter S. M. T is a test terminal with which most service meters are equipped for convenience in testing; this terminal is shown in its normal closed position. For certain tests it is opened, as will be explained later.

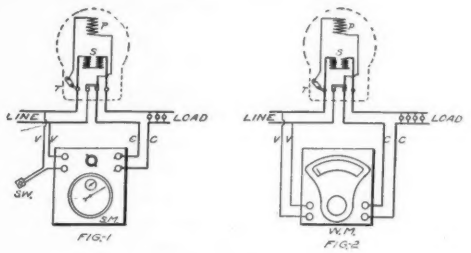


FIG. 1. CONNECTIONS FOR TESTING TWO-WIRE SINGLE-PHASE WATTHOUR METERS

FIG. 2. TWO-WIRE SINGLE-PHASE WATTHOUR METER TESTED WITH INDICATING WATTMETER

Set the service meter level and connect as shown, being sure to have the potential leads V V from the test meter connected on the line side of the service meter, and the current leads C C on the load side, so that neither meter shall record the losses in the potential circuit of the other, which would introduce appreciable error at light loads. One potential lead of the test meter has a push button switch, Sw, for starting and stopping the instrument. If the pointer on the test meter does not run in the proper direction, reverse either the potential or current leads.

Note the reading of the test meter and start this meter simultaneously with the counting of the disk revolutions of the meter under test. Count the revolutions of the service meter disk for about 1 min. and stop the test meter. The number of revolutions of the service meter disk multiplied by the constant marked on the disk equals the watthours recorded by it. The same rule applies to the test meter, the proper constant for the test meter depending on the current coil used, which is given on the instruction card accompanying the meter. It is well to use the same current coil that is marked on the service meter if the testing load is near full load. If the service meter is of 5 amp. rating, use the 5-amp. coil of the test meter. For testing with light load, a lower ampere coil can be used.

The ratio of the number of watthours recorded by the service meter, to the number of watthours recorded by the test meter, equals the accuracy of the meter. For example: service meter, 5 amp., 110v., disk constant 0.25. Test meter constant using the 5 amp. coil, 0.3. Revolutions of service meter 12; revolutions of test meter 10.

$\frac{0.25 \times 12 = 3}{0.3 \times 10 = 3}$, which shows that the service meter is correct. Suppose that the test meter made 9.25 revolutions while the service meter made 12. The example would be:

$$\frac{0.25 \times 12}{0.3 \times 9.25} = \frac{3}{2.775} = 1.08,$$

indicating that the service meter is 8 per cent fast. If

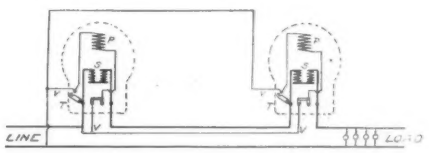


FIG. 3. CONNECTIONS FOR COMPARING PERFORMANCE OF TWO SINGLE-PHASE TWO-WIRE WATTHOUR METERS

the test meter made 10.5 revolutions while the service meter made 12, it would be:

$$\frac{0.25 \times 12}{0.3 \times 10.5} = \frac{3}{3.15} = 0.952; \quad 100 - 0.952 = 0.038$$

which shows that the service meter is 3.8 per cent slow.

The full load adjustment of meters is made by shifting the damping magnets. Moving them towards the disk shaft increases the speed of the meter; moving them out slows the meter. This movement is accomplished in most meters on a micrometer screw after the

clamp screws of the magnet are loosened. With meters that have a cup-shaped disk the speed is decreased by moving the magnet toward the cup, and increased by moving in the opposite direction. The light load adjustment is made by varying the position of a light load plate. This adjustment varies with different types of meters, but is given in the instruction book accompanying the meter. It is generally not necessary to check full load calibration unless more than a 10 per cent change is made in 1/20 load calibration.

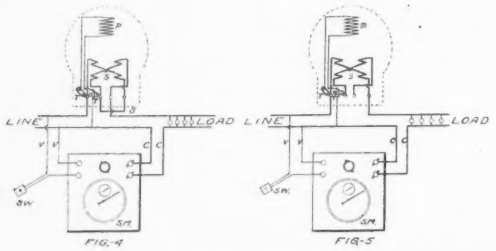


FIG. 4. CONNECTIONS TO BE USED IN TESTING A SINGLE-PHASE THREE-WIRE METER AS A TWO-WIRE METER WITH TWO CURRENT COILS IN SERIES

FIG. 5. SAME AS FIG. 4, BUT WITH ONE CURRENT COIL CUT OUT OF SERVICE

Figure 2 shows a single-phase two-wire meter being tested with an indicating wattmeter. In this test a watch must be used (a stop watch preferred). The formula is $\frac{3600 \times R \times C}{S}$ = watts recorded by the service meter. R = revolutions of disk; 3600 = seconds in 1 hr.; C = constant on disk; S = number of seconds required to complete revolutions R. This divided by the load shown by the indicating wattmeter will give the accuracy of the service meter. If the time S is 60 sec. the formula can be shortened thus, $60 \times R \times C$ = watts.

In Fig. 3 are shown the connections for comparing two single-phase two-wire meters, or using a service meter

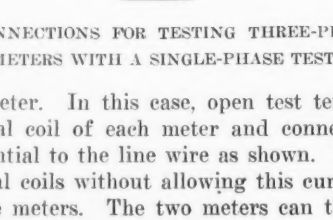


FIG. 6. CONNECTIONS FOR TESTING THREE-PHASE THREE-WIRE METERS WITH A SINGLE-PHASE TEST METER

as a test meter. In this case, open test terminal T of the potential coil of each meter and connect this side of the potential to the line wire as shown. This excites the potential coils without allowing this current to flow through the meters. The two meters can then be compared as when using a test meter.

Figures 4 and 5 show a single-phase three-wire meter being tested as a two-wire meter. The external appearance of this meter is similar to the two-wire meter; but it has two sets of current coils, while the two-wire meter has but one set. This is necessary, for, if but one coil were used, current could flow through one line and return through the neutral wire and would not be recorded by the meter. In Fig. 4 the two current coils are connected in series at s. One test terminal, T, is opened as shown, a lead from the potential coil being connected to the line wire. The meter is tested as for a two-wire meter, the constant on the disk being used. Figure 5 shows this meter tested with one current coil alone. In this case, the constant on the disk must be multiplied by 2, as current is flowing through but one coil.

Figure 6 shows this meter tested as a three-wire meter with a two-wire test meter. If the voltage is 220 v. between the outside wires, the test voltage should be the same, the neutral wire not being connected to the load, sets of two 110-v. lamps in series being used for the load. The test meter should be set for 220 v. and the constant on the service meter disk used.

Figure 7 shows the connections for testing three-phase three-wire meters with a single-phase test meter. Connect the two current coils in series and the potential coils in multiple as shown. The constant to be used is the disk constant divided by 2. After connecting, open one

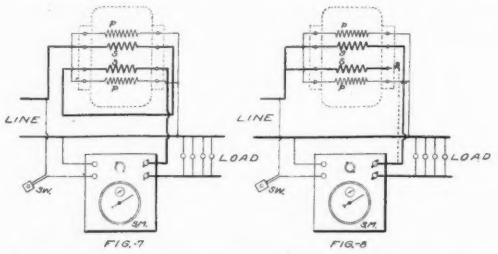


FIG. 7. CONNECTIONS FOR TESTING THREE-PHASE THREE-WIRE METERS WITH A SINGLE-PHASE TEST METER

FIG. 8. SAME AS FIG. 7, BUT CONNECTED TO TEST EACH CURRENT COIL SEPARATELY

potential coil at a time and note whether the meter runs in the proper direction. If the meter runs backward, reverse one or both potential leads, as the case may be.

In Fig. 8 this meter is shown connected to test each current coil separately. The connections show the upper coil connected. To test the lower coil, disconnect at A and connect at B, as shown by the dotted lines. Use the disk constant.

The foregoing test is for three-phase meters that are used without potential or current transformers. When testing a meter used with transformers, but testing without the transformers, the testing constant is the constant marked on the disk divided by the product of the ratios of the current and the potential transformers. For example, meter to be tested: 40 amp., 2200 v., three-wire three-phase; constant on the disk 80. This meter is used with current transformers having a ratio of 8:1 and potential transformers with a ratio of 20:1. The meter is tested without the transformers as a 5 amp. meter. The test constant is found as follows: $80 \div (20 \times 8)$ or 0.5; this is used when the current coils are tested separately as in Fig. 4. With the current coils in series as in Fig. 3 the constant is $0.5 \div 2$.

In a plant operated by the writer a three-phase 2200-v. watthour meter was used on the switchboard of

the size given above. As the load was to be increased to such an extent as to overload this meter with current transformers having a ratio of 8:1 and to save the cost of a new meter, current transformers having a ratio of 16:1 were used and the meter reading multiplied by 2. With current transformers of 16:1 it required 80 amp. on the line to load the meter. With the 8:1 transformers 40 amp. would load the meter, 5 amp. being the full load current through the meter.

When disconnecting a meter from its transformers always short-circuit the secondary of the current transformers before disconnecting them from the meter; for, if the secondary circuit of a current transformer is opened while current is flowing through the primary, a high voltage builds up across the break, tending to continue the flow of current in the secondary in proportion to that in the primary. This high voltage is dangerous, and is likely to damage the transformer insulation.

Burning Holes for Conduits

By Gordon Fox

INASMUCH as the practice of burning steel to make holes for conduits and for other electrical construction work is not very general, it might be of interest to relate the use which the oxy-acetylene torch has found in the construction of some steel mill buildings recently erected.

The buildings were of structural steel framing. All the electric wiring was run in conduit and there was a great quantity of conduit to be run. In order to avoid excessive bending of conduits with its attendant cost and with the pulling difficulties introduced, an oxy-acetylene torch was purchased and holes were burned in beams, gusset plates and other members to allow the conduits to pass directly through them. Care was exercised, of course, to avoid weakening the member. For instance, in beams the holes were burned only near the center of the web where the stresses in the metal are a minimum. This method has proved extremely effective through elimination of bending work, through decreasing the trouble of supporting conduits which are run through the structural members and through aiding in easy pulling of wires. The appearance of the job is also enhanced, as most of the conduit is concealed behind the steel members with no ugly bends around the joints.

It was not long before the men learned how much more quickly a hole can be burned than drilled. The electric drills soon became idle and the torch was in great demand for burning holes for U-bolts and J-bolts for fastening conduits or for bolts for attaching brackets and the like. In this service, many hours have been saved and much expense avoided, and the job is equal in appearance and serviceability to one in which all holes are drilled.

It happened soon after the torch arrived that a panel board cabinet was erected and it was found that one or two of the knockouts were not most conveniently located for the conduit runs. The torch soon remedied this condition by burning new holes in the desired locations. Soon all cabinets were purchased without knockouts and the conduit holes burned in the field just where required. This proved both an easy and effective arrangement.

In heavy soldering work the torch also found a demand, as it is possible to heat up large lugs or cables in much less time with the gas torch than the ordinary electricians' torch.

One torch proved entirely insufficient and it was necessary to provide three equipments. Even then the demand was greater than the ability to perform. These three torches are still the busiest tools on the property.

Oxy-Acetylene Welding for Engineers

By Chas. Haeusser

HAVING advised the purchase of an acetylene gas welding outfit, and assured my employer that it would be a paying proposition and that it would help the firm out of "many a hole," such an equipment was purchased. I was sent to a welding school conducted by the manufacturer of the apparatus for one week of practical instruction.

Upon my return, the outfit was there, as were also a number of broken parts of machinery, with production stopped on these machines. As these were only simple cast iron breaks, I had these machines going the same day, which pleased the management very much.

My four months' experience has shown this welding outfit to be more useful than our forge, lathe and drill-press combined. Some of the things I accomplished were straightening warped grate bars, welding and bending large pipe, building up worn shafting and joining broken shafting; joining pipe rails and making machinery guards, also for building up teeth in gears, and a thousand other uses too numerous to mention.

I have also made some interesting experiments, one of which is to burn a hole through iron pipe, which was full of water; of course, the pipe was not plugged or capped at one end.

Have also taken tungsten filaments from an electric bulb and melted it into the end of a cold chisel to make the chisel cut chilled cast iron; but for some reason or other this experiment does not always succeed.

I would like to know how to test oxygen gas for the presence of hydrogen, and also what will prevent hard scale in welding cast iron?

Results from the sale of War Savings Stamps and Thrift Stamps show that the country is saving its pennies to help Uncle Sam win the war. During December, January, and up to February 12, the sales reached a total of $50,586,343, and the increase has been such that the nation is now saving and investing some $2,000,000 a day in these little securities.

This is encouraging, because a large part of this saving is from small expenditures which fritter away large sums in the total without bringing the spender any permanent good or satisfaction.

Larger sums are well put aside for investment in the third Liberty Loan Bonds, which will soon be placed on the market. We must spend billions to support our fighting men and make our army and navy effective.

Plant Improvements Resulting in Coal Saving

CONTINUOUS OBSERVATION OF RESULTS LEADS TO IMPORTANT RECOMMENDATIONS BY ENGINEER WHICH WERE TURNED DOWN BY THE MANAGER BUT LATER ADOPTED. BY S. J. H. WHITE

RECENTLY the Government sent a bulletin to all steam users, urging that steps be taken to conserve the coal supply, and offering several practical suggestions to accomplish this result.

The author of this Government bulletin is unquestionably a very practical man, and does not hesitate to lay the blame for waste of coal, in the majority of plants, exactly where it belongs. The writer's own experience, as works engineer and industrial engineer in several states, has proven beyond doubt that the average business manager is responsible for enormous waste of coal, due to his aversion to any consideration of boiler house matters, excepting to insist on the employment of the cheapest help.

The methods of saving coal are simple, well known for years by the engineer, and do not require large investments in the majority of plants; but even reasonable investments, if requested to conserve fuel, should be made, and at the present price of coal will return handsome dividends.

The preventable losses in the power and heating department are known by the engineer to exist; he has known of them for years, but he is powerless to remove them unless furnished the necessary devices and equipment. Provide him with what he needs, and he will "make good."

The author of this article frankly cannot understand why factory managers persist in absolutely throwing away hundreds of dollars every month in wasted coal, which can be so easily saved and applied to the dividend fund. The manager hires a man as works engineer, presumably because he feels the necessity for such a head, and undoubtedly because he has confidence in the man's ability to fill successfully the position; yet when the works engineer asks for $100 worth of pipe, for instance, the installation of which he knows will save $500 worth of coal in a year's time, he is told "nothing doing"; this is an actual experience of the writer's; a year later, however, he made the same request which was granted, and the company had over $500 saved on account of it in less than a year.

The factory, of which the writer is the works engineer, had the worst designed heating system imaginable; the heating steam had to travel through 360 ft. of 8-in. very poorly insulated underground main, between the boiler house and main building; after entering the building, it had to travel back toward the boiler house a distance of 250 ft. to heat that end of the building through the inside main; this end of the building was only 52 ft. from the boiler house: the writer suggested 4 yr. ago that a sub-main be run from the boiler house to this end of the inside main in order to heat the end of the building properly, and such main would have relieved the load on 8-in. main resulting in a general improvement, as well as saving considerable coal; the cost of installing this sub-main would have been about $100 and the management refused to permit the installation; each succeeding year the same request was made, and the complaints of the employes working in departments at this end of the building were taken before the manager, stating that they were compelled to work in cold rooms; still the manager would not permit the improvement on account of its cost, until this year when the cost of coal advanced so tremendously the work was ordered done, and was completed in September; during the first month and a half $60 worth of coal was saved, and there was no complaint of cold rooms.

The sub-main mentioned above proved of such great benefit that other suggestions made by the writer relative to improving the heating system were acted upon, with the result over 20 per cent has been saved on the coal consumption during those 45 days of moderate weather, so that in severe weather it is reasonable to expect even a larger saving.

The type, size and location of the boiler plant was selected by a consulting engineer over the writer's protests with the result that over 30 per cent of the coal consumed is wasted from these causes alone. The boiler broke down last winter, due to no other cause than overload, and the writer was instructed to purchase and install another boiler, which enabled him to select the type and size he wanted, but had to install it, of course, in the poor location of the other boiler, as there was no room in the boiler house for the additional boiler. This new boiler being much larger than the old one, a new stack was required; and while the writer advised not less than 125 ft. in height, he was forced to accept a 75-ft. stack, but succeed in getting a 16-ft. pedestal on which to mount the stack, which helped some, giving a 91-ft. stack, while the old boiler was compelled to work with a 60-ft. stack.

The following comparison of results between the two boilers is interesting:

During two heating seasons, Sept. 25 to May 25, 1915-1916, for old boiler, and Sept. 25 to May 25, 1916-1917, for the new boiler, the coal consumption was as follows: The old boiler consumed 2,000,000 lb. coal in 2770 hr.; 722 lb. per hr.; the new boiler consumed 1,800,000 lb. coal in 4410 hr.; 408 lb. per hr.

While daily temperatures of weather were not kept, the weather of course very materially affects coal consumption in heating plants; the fact that heat was required so many more hours with the new boiler indicates that the weather during that season must have been more severe than during the preceding year.

The writer has repeatedly asked for more and better steam traps for the various steam consuming devices connected to the high-pressure manufacturing steam main, but his requisitions were turned down; the trap leakage finally became so great it was hard to maintain the vacuum, and something had to be done, as many of the traps were beyond repair; and in some cases the writer was forced to connect as many as seven different devices on one trap, which caused the devices to work only fairly well and wasted a large amount of steam. As the company refused to purchase the necessary traps, the writer designed a very simple expansion type of trap made out of standard pipe fittings, a short piece of pipe,

and a piece of brass rod; he had his head millwright make up 15 of these traps, and installed them where required; these home made traps are saving 2000 lb. of coal per day, the devices heat up in less than half the time required with the old traps; further, the spray water for the vacuum pump is only 25 per cent of that formerly used.

The manager could not see his way clear to buy nor any necessity for a feed-water heater, as the returns from the vacuum system "seemed hot enough for any boiler" (the temperature was about 120 deg.); so the writer found an old steel tank which had been discarded and used it in connection with some old pipe and fittings to construct a heater; he was surprised with the success of this heater; the feed water now enters the boiler at 212 deg., being heated entirely by the exhaust steam from the boiler feed and vacuum pumps, and has resulted in a saving of coal amounting to very nearly 1000 lb. per day.

We weigh our coal as used, weigh ash, measure feed water by meter, read the various electric meters, and keep a very complete daily record of coal consumption, evaporation, fuel burned per square foot of grate area, kw.-hr. consumed, etc. Each day's record is compared with preceding days, and each month's record is compared carefully with preceding months.

Where heat and power can be purchased from a central station at reasonable rates, under some conditions it will prove slightly more profitable to the factory than to generate its own power and heat; but it requires very careful figuring to determine which is the cheaper plan in the majority of cases where the mechanical load exceeds 100 hp.

In case the factory is located at a distance beyond the reach of the central station heating system, necessitating the operation of a steam plant for heating and manufacturing purposes, it will almost invariably pay to install a power generating unit, and use exhaust steam from it for heating the buildings.

A reasonably good power plant, properly handled, will develop a horsepower on 2 or 4 lb. of coal per horsepower per hour; the exhaust steam, nine times out of ten, will be sufficient to heat buildings; whereas if live steam is used for heating, it will require 7 to 10 lb. of coal per horsepower per hour on an average for the heating season, owing to the fact live steam after passing through reducing valves is super-heated and put into a condition thereby in which it is least adapted for heating purposes, as it does not readily give up its heat; while exhaust steam is exactly in the proper condition for most efficient heating, as its condition is such that it readily gives up its heat; further, the boiler capacity must be sufficient to meet the demands for steam in very severe weather, which exists comparatively few days in the year, consequently the boilers will carry a decided underload during the bulk of the year, with consequent serious losses in efficiency most of the year.

Conditions of underload on heating boilers can be offset to a limited extent by the installation of two or more smaller boilers, only sufficient number being fired to meet the demands for steam; but this results in losses, and seriously increases the investment.

In case a power unit is installed, practically a uniform load is maintained on the boilers throughout the year; consequently the boiler efficiency is maintained constantly, which materially reduces the coal required by the power and heating plant, compared with the heating plant by itself. This point is frequently overlooked by engineers.

Again, if boilers are maintained for heating and generation of steam for manufacturing purposes only, they will undoubtedly consume as much coal as they would if they also carried the mechanical load, at least during the heating season, hence the amount of coal consumed by the central station to produce the power you purchase form it, will be wasted; so figuring on the most favorable basis possible, the private power plant will always prove a coal conserver at least during the heating season. In some cases, however, where it is possible for the central station to furnish both heat and power the private plant may be a waster of coal.

While many business managers have the utmost confidence in the benefits derived from advice of consulting engineers, such benefits while frequently great, at the best are very short lived. The efforts of the consulting engineer usually result in a decided improvement in plant efficiency; but the improvement cannot be permanent, as conditions are constantly changing, and the only remedy or means of securing permanent high efficiency is by daily supervision by a competent engineer; there are firms of supervising engineers who are proving themselves extremely valuable to their clients; it is not necessary for a supervising engineer to visit your plant every day, but he must, in order to maintain maximum economy, be furnished an accurate daily report on your plant covering essential data, from which he can compare one day's run with another, and instantly detect any change in efficiency, and then take the necessary steps to locate and remove the causes producing the change.

As a rule if the works engineer, or in smaller plants not employing a works engineer, the chief engineer, is given the proper co-operation and the necessary instruments and equipment, he can and will secure and maintain maximum efficiency in the plant without any outside assistance; of course, the supervising engineer with many plants under his control has the advantage over the local engineer, in so far as he has the data at hand enabling him not only to compare daily records from one plant, but also to compare its operation with the records from various other plants.

The writer has found it difficult to interest the management of many plants in the monthly or yearly reports submitted to him; this lack of interest on the part of the business manager has resulted in fearful loss of money and waste of coal; this aversion of business managers to give the power and heating department proper consideration is clearly shown to be almost an universal characteristic in this country by the fact that the Government has found it advisable and necessary to publish and distribute a bulletin practically accusing business managers of their neglect in this respect.

As an illustration of the value of examining yearly reports of power and heating department the writer will mention a case where reports on a certain plant of which he has knowledge were not examined: the cost of heat, light, power, steam and water for a certain year was in round numbers $5000 during which year the

various supplies were generated by private power plant; the following year this plant was moved to another city, and in order to save $10,000 investment on power unit, the business managers insisted on buying power from central station and installing boilers to generate steam for heating and manufacturing purposes; the quantities of heat, light, power, steam and water consumed were practically the same during the second year, but the cost of these supplies was in round numbers $12,000; the cost of coal per ton was slightly higher in the new location, which accounts for a small part of the $7000 difference in operating expenses; with such reports before the manager's eyes, if he examined the reports, it seems almost unbelievable that he would persist in buying power.

Now that coal has advanced to such abnormal prices, possibly conditions will change; the writer's object in writing this article is to "do his bit" for the good of the country toward the necessary conservation of coal.

Treating Boiler Scale with Kerosene

METHODS TO BE EMPLOYED AND PRECAUTIONS REQUIRED. BY LIONEL LINNELL

ADVICE regarding the use of kerosene might be almost entirely confined to discussing the dangers and methods of combating them. Unless used carefully kerosene may result in accident, because when heated or sprayed it forms a vapor that is readily ignited in the presence of a naked flame, and moreover human beings may be asphyxiated by these fumes. Realizing the danger and the exercise of care largely overcomes them.

Kerosene is different from graphite in boiler-scale treatment in that the latter is used with the boiler in service and the scale wet, whereas kerosene is usually used after the boiler is taken out of service and after the heat from the settings has dried up the scale. The best results are obtained with kerosene with dry scale for it then works in between the scale and the boiler surfaces, breaking up the former and separating them from the latter. It is thus seen that graphite is really a method of treating boiler surfaces and scale while the boiler is in service, kerosene a method of treating scale after the boiler has been taken out of service.

There are those who advocate feeding kerosene drop by drop in with the feed water, in the same way that graphite is used for scale treatment. The exponents of this practice claim the kerosene changes the form of the scale, making it more granular in form, and more easily removed from the boiler therefore. Kerosene has, however, no chemical action upon boiler scale.

USING KEROSENE DURING SCALE REMOVAL

AFTER a boiler has been shut down, the water drained off and the surfaces are still a little warm so as to dry the scale, kerosene may be sprayed in so as to cover every part of the boiler in sufficient quantity to enable it to soak in behind wherever scale is lodged. The boiler should then be allowed to stand while the kerosene works in between the interstices and cracks and under the bottom of the scale. When the kerosene has penetrated properly, hammering gently on the boiler or tubes with a hammer will cause the scale to fall and break up in chunks with comparative ease whereas without the use of kerosene continued hammering and the use of scale-removing tools must be resorted to. All scale may not come off by hammering, but some particularly hard stony patches may require chipping, but in any case the use of kerosene helps materially and shortens the time the boiler must be down for scale removal. The ability to remove the scale comparatively easy with less hammering and chipping is, however, perhaps of even more importance, since the less vibration to which the tubes are subjected reduces the liability of weakening them from this cause, and lessens, therefore, the chance of ruptured tubes, etc. In any case, it is never a good policy to use the hammer on one spot longer than necessary, and if a few blows do not accomplish results go back to it later after the kerosene has had time to work.

When the scale has all been hammered loose the boiler should be thoroughly and vigorously washed out with water under good pressure so that any scale that may happen still to adhere in small quantities here and there may be removed and washed down, otherwise it will fall down upon the heating surfaces at a later date and probably cause local overheating and bulging or "bags." As pointed out when discussing the use of graphite for scale treatment, a boiler that has been treated with kerosene should be opened much earlier than one not so treated, because there is always a certain amount of scale that comes down after the boiler starts steaming again, being forced down by the vibration, movement of the metal surface and the ebullition of the water presumably. If not removed, this precipitated scale will cause damage.

PRECAUTIONS IN USING KEROSENE

KEROSENE VAPOR should never be sprayed into a hot boiler, for when mixed with the proper proportion of air it forms an explosive mixture. Every precaution should be exercised to prevent its ignition otherwise damage to persons and property are liable to follow. No naked flame should be taken in or around a boiler that is being or has been treated with kerosene until the inside has been thoroughly washed out with water spray and ample time has elapsed for effective ventilation. Only an electric lamp, well protected against breakage should be used during the use of kerosene. There is always possibility of persons entering the boiler being overcome with kerosene vapor unless the boiler is amply ventilated before they enter. Moreover some of the vapor may remain even after the unit has been in service, hence it is always a wise measure to ventilate it will when next taken out of service.

Kerosene is preferable to crude oil in treating scale after a boiler has been shut down. It is, however, a practice that should be followed only by men able to appreciate the dangers and the precautions necessary to prevent them. At this time every means is desirable for economizing coal by maintaining the inside and outside boiler heating surfaces efficient for heat transmission, and kerosene may be used for doing this. The writer believes it should be used only as a last resort and after graphite has failed in its purpose, which it is

unlikely to do. In any case, with changing labor conditions, with new men on the job, and possibly working for long hours, the use of kerosene should be employed only under capable supervision.—Electrical Review.

Points on Babbiting

By Receiver

IN plants where the engineer has charge of the shafting, pulleys and belts, the bearings will sometimes get hot, and if this continues too long the babbit may melt. If an abundant supply of oil fails to cool the bearing, graphite, white lead or mica is sometimes useful; however, if mica is used, care must be taken to rub some of it in the hand, and if it all rubs to an impalpable dust it is safe, but if any hard particles remain in the hand it is proof of grit which will increase the heat if put in the bearing. Usually, after a bearing has been heated, it is desirable to take it out and rescrape it to a fit and to dress up the shaft with a smooth file. Where but little of the babbit has melted, the bearing may also be made to give longer service before rebabbiting by running off the belts near the bearing, jacking up the shaft to take the weight off the box, then removing the bearings, carefully scraping off the rough places and draw-filing the shaft diagonally to take out any scratches. The shaft and bearing should be well oiled before replacing, and it is well to be sure that oil grooves are cut in the babbit.

When a bearing must be rebabbited, remove the old metal with hammer and chisel, taking care to clean out the holes which are bored in the backing, so that when the new babbit is put in the metal may flow into these and securely anchor it. If such holes are not provided, they should be drilled.

How Thick?

Next, secure a proper arbor around which to pour the metal. Such arbors are commonly made of wood, but if many bearings of the same size are to be babbited a metal arbor may be made and is to be preferred. Since the babbit must come above the surfaces of the box at the sides, in order to keep the shaft from rubbing on the cast iron, the boxes are of greater diameter than the shaft, and to determine what thickness of babbit is to be used, measure the inside diameter of the box after the old babbit is removed, and the diameter of the shaft. The thickness of babbit will be half the difference between these diameters.

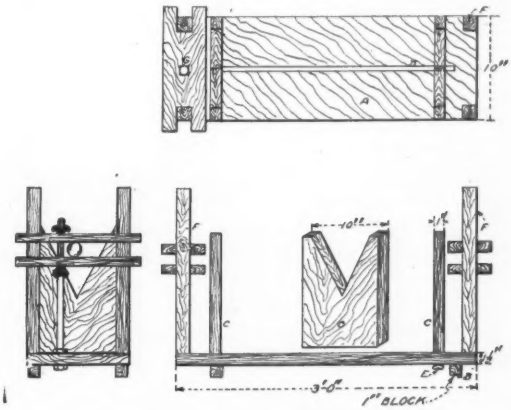
Strips of leather of the right thickness and of sufficient length to encircle the arbor may then be cut and the arbor rested on these at the ends of the box, thus giving the proper depth of metal between the arbor and the bottom of the box. The ends are then sealed with putty or fire clay to prevent the molten metal from running out, and a weight or clamp put on the arbor to hold it down, so that as the metal is poured the arbor will not float out of place. The arbor should be coated with oil or chalk to prevent the babbit metal adhering to it and some prefer to put a little rosin in the bearings, thinking that this tends to prevent the metal from flying when coming into contact with the cold box or with any possible moisture.

Heating and Pouring

It is always advisable to heat the bearing before pouring the metal, since this will avoid chilling the babbit so quickly and gives a better chance to fill the bearing completely. If metal arbors are used they, also, should be heated. Heating the box will also drive off moisture, and great care must be taken that none is left in the box and that no water is allowed to drop into the molten metal, as this moisture will cause the metal to fly in all directions with possible danger of burns to the workman.

Care should be taken not to overheat the babbit, as if this is done the tin is burned and the life of the metal reduced. The metal should be sufficiently hot to char a soft pine stick which is thrust into it, and then is hot enough to pour. In placing the bearing for pouring, care should be taken to get the arbor level so that there will be the same thickness of metal at all points.

Having considerable babbiting to do in the upkeep of a large plant the writer made the jig shown in the illustration as follows: A piece of 1½-in. plank, A, 10



JIG USED IN BABBITING BEARINGS

in. wide and 3 ft. long, which was of sufficient length to cover the largest bearing, had two blocks, B, 1 in. high secured at each end to act as feet. A piece of wood, C, 1 in. thick and 10 in. wide, with a large V-cut in it was made fast near one end of the plank, and another similar piece with a bolt and thumb nut, E, projecting through a slot, D, in the plank could be moved along so as to take care of a bearing of any length. At each corner of the plank guide posts, F, were fastened, and sliding upon and down on these was a clamping, G, having through it a ½-in. bolt with long thread and thumb nuts above and below to be used in holding the arbor in place. The bearing is placed on the plank between the V-blocks, the arbor resting on the clamps and adjusted so as to give the right thickness of metal, and the clamps then pulled down onto it to hold it firm. Some 600 bearings have been babbited on this jig with entirely satisfactory results. For important bearings, such as those on the crank and wrist pin or main bearings on an engine, the babbit should be poured at least ¼ in. diameter smaller than the finished size, so that the metal may be honestly hammered into position, then bored out to size to get a good job. For a crankpin box, in

a connecting rod of the gib and key takeup type the thickness of babbit may be found by having the key just come through the strap, flush with the gib. When the solid end rod is used with the wedge out as far as it will go and the box moved back into contact with the wedge, half the opening between the boxes is the thickness of metal required. Bearings should always be scraped after pouring until they form a good fit on the shaft, and oil grooves should then be cut, preferably in diamond or X form.

Drawing and Fitting Keys

By F. R. Parsons and C. F. Woodcock

THE extraction of keys is often a problem taxing to the uttermost the ingenuity of a mechanic. Where the process is simplified by the best of conditions prevailing, that is to say, when nothing prevents the free use of a suitable key drift, and there is ample room to swing a hammer, a key that was originally well fitted, and greased before insertion, usually presents few difficulties in the way of extraction. It is in those instances where a key is rusted in, or has become loose sidewise, worn the key groove, and attempted to mount the shaft, or else by reason of its position, or the proximity to some obstructing features which prevents the employment of the usual methods to start it, that the mechanic experiences trouble. Then it is that ways and means specially applicable to the peculiar circumstances

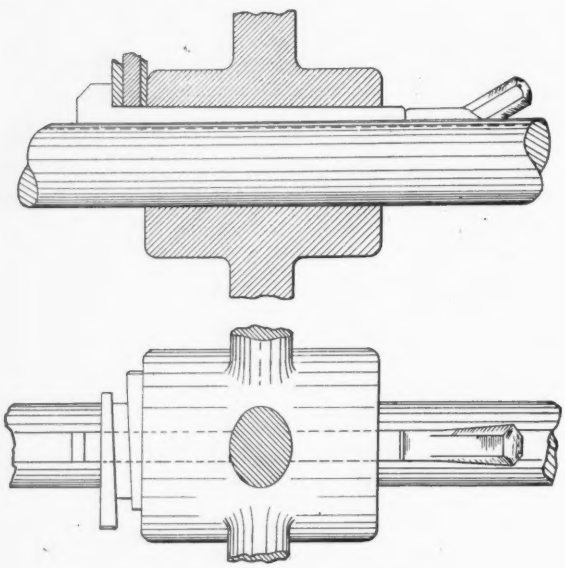


FIG. 1. STARTING A KEY BY WEDGES

met with, and individually suiting each particular case, must be devised.

If, by reason of the restricted use of a key drift, it becomes difficult to start a key, one of the simplest and at the same time most effective methods to employ is that shown by Fig. 1.

Oftentimes a key will come away readily for an inch or so and then seize in the groove, and under the heaviest blows and most forcible persuading refuse to budge another sixteenth. If a drift of ordinary thickness will not effectively reach the key end so as to give it a smart, solid blow, a steel packing piece, a little less in width and thickness than the key groove, and sufficiently long to reach just outside the wheel boss, should be inserted as shown in Fig. 2. Failing this form of persuasion it is a good plan to force oil into the key groove, behind the key, also to apply some to the large end, then to drive the key back home again, repeating this two or three times until freer conditions prevail.

Usually keys have a head shaped as in Fig. 3A. This form answers very well under certain conditions, but when a key requires drawing mainly from the head it is not unusual to find them develop a fracture at the point shown. In such circumstances a key having a head similar to that shown in Fig. 3B will be found to be

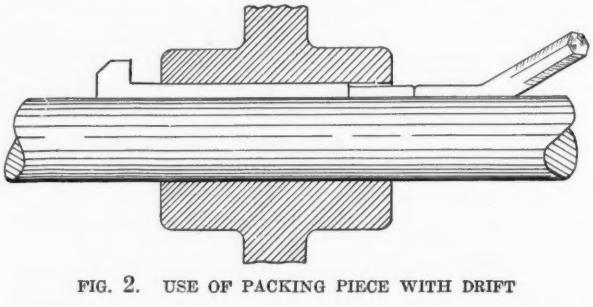


FIG. 2. USE OF PACKING PIECE WITH DRIFT

much stronger and less liable to distortion and fracture. Moreover, such a type permits the employment of a drawing device, as in Fig. 4.

Not infrequently trouble is experienced in drawing a key when it happens that the pulley or wheel has a recessed bore, this fact not being known by the operator. And if the recess is of such a depth as to come below the key groove as shown in Fig. 5, then it might well happen that the key, if tight at the large end, or rusted or seized up, will become bent upwards under

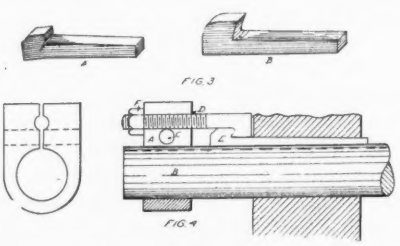


FIG. 3. ORDINARY AND IMPROVED SHAPE OF KEY HEAD
FIG. 4. KEY DRAWING DEVICE

the force of the blows put upon it, and so fill the recess. In such an instance the only effective remedy is to cut off both head and key end fair with the boss, and to drill it out—always an undesirable and tedious operation.

A method of drawing a headless key is shown in Fig. 6. This applied, and the boss all round given a few jarring blows near the shaft, is generally productive of a quick and favorable result.

Figure 7 indicates another form of key trouble, this being encountered when the shaft end is but a short distance through the wheel or pulley, and the key overhangs. Failing facilities for drifting behind in the usual way, and an inability to drive the wheel on the shaft, the only alternative is to put the persuading element on the head of the key, more often than not with the result shown. When this occurs, and the key is not fractured, a red-hot pair of smith's tongs should be gripped on the key, and held there until the key is quite hot; this will eliminate further chances of fracture when straightening it. The latter operation might be accomplished with safety, as shown in Fig. 8. The key well

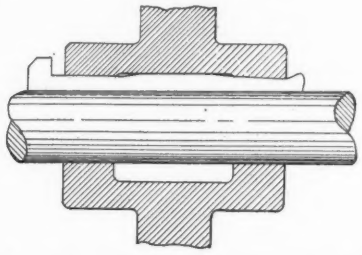


FIG. 5. KEY BENT UP IN CENTER AND AT END

packed in this way can then be drawn as in Fig. 1. In all cases when using a drift to start a key, the chief thing to remember is to get home firm and solid with the first blow. For if at this time the key refuses to start, every lighter blow delivered afterward might well add to the difficulty of removal.

Keys will be found to come away much easier if the pulley or wheel is turned over, so that the key is on the bottom side of shaft—of course assuming that the shaft is supported in its bearings or otherwise and the wheel is hanging on the shaft. A very little reflection will convince anyone of this, particularly if the wheel is heavy and anything of a slack fit on the shaft. Also, in fitting a new key it is always preferable to have the key-

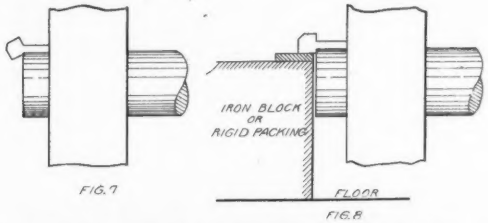


FIG. 7. BENDING WITH OVERHANGING KEY
FIG. 8. METHOD OF SUPPORTING OVERHANGING KEY

ways on the bottom side of shaft, if the shaft is supported and the wheel hanging. But if the wheel is supported and the shaft lying in the wheel, have the keyways on the top side. Otherwise much unnecessary driving and false fits are shown owing to the key having to lift the wheel or the shaft. This does not apply if the wheel is a shrunk or pulled-on fit.

A very useful tool for drawing keys is shown in Fig. 9.

Several sized bars should be made and kept handy. They give tremendous leverage, and with the aid of a few blows with a sledge-hammer on the opposite side of wheel boss, will be found capable of drawing almost any key. The bars should be so shaped, and assisted with packing pieces, if necessary, as to give the starting pull right down in the root of key ahead. Otherwise they will pull the key head off. Naturally they must be made of best steel.

When fitting a new key, it is always best to get the wheel onto shaft first. Caliper for size and order smith to forge it, allowing a little extra for fitting in. Then take particular notice that both keyway in wheel and in shaft are parallel with one another and exactly the same size. If not, correct by filing. For faults in parallel always correct the wheel. This will allow the wheel

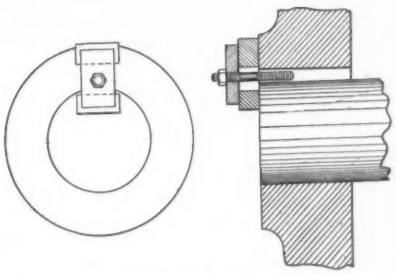


FIG. 6. DRAWING A HEADLESS KEY

to be put at any point along the shaft as far as keyway extends for final driving up of key. Another particular point to notice is that the top of the keyway must be parallel with the bottom, that is across the keyway, not in length, which of course must taper. Should it not be so, the key, when being driven in for fitting, will be wedged over to one side and a false fit sideways will be obtained. After looking for and correcting these possible faults, remove (if not too heavy) the wheel from the shaft, and then fit the key for side fit to both wheel and shaft. Next true up the bottom of key with square and

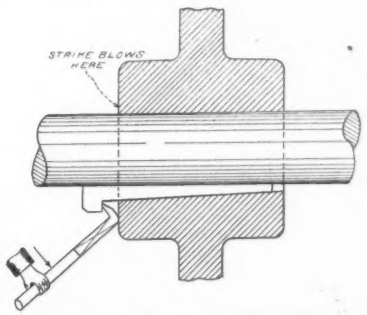


FIG. 9. A HANDY TOOL FOR WITHDRAWING KEYS

straight edge. Then replace wheel and fit the key, driving lightly in and then withdrawing and easing where necessary, repeating until key is a good fit all over and into the required length.

Should the wheel be slack on the shaft it is best to make the key fit well at the two ends and slightly ease the middle off. This will bring the wheel up square on the shaft.

If two keys at 90 degrees round shaft have to be fitted to a wheel, particularly if the wheel is a slack fit, I find it best to fit both keys together, that is, first a bit at one and then a bit at the other.

Always *well* chamfer off the small end of a key. This will allow for the bringing up, which is unavoidable when driving out by drifts and sledge-hammer.

The drift should be as big in section and as stumpy and straight as possible, to avoid the blow being lost in spring. THE POWER USER.

Boiler Feeding

THE FIREMAN, OFF DUTY, DIGS INTO REGULATING COAL, WATER AND AIR SUPPLY TO KEEP HIS BOILER CONTENTED

AFTER I spent that Sunday looking up how coal was formed, I got to studying that coal pile and I could see those forests and swamps, and the process all going on until the coal got down here ready for my shovel. And I kept thinking of the thousands of years it took to store that heat and get it ready, and the seconds the coal lasted in the furnace. And then I thought, with all that trouble to get the heat here, it's a shame to let any of it get lost; so how could I make sure to save as much as possible of it?

We burn bituminous, and I took to watching the furnace to see how it acted, and asked the chief and the super questions, and then read some books I got from the library. And I found that there were other things than just shoveling in coal in order to keep those heat units from flying up the stack.

That coal has a lot of gases tucked away in it, and it didn't get compressed very hard in the making, so there's a lot of tarry matter, too, that boils off quickly when the coal gets into the hot furnace. The books called it volatile matter and it flashes up in a long flame and gets smoky if the air supply isn't right. So I have to look out for the damper as well as shoveling in too much at a time on one spot.

We had some sample carloads in on trial, too, and I watched the way those worked. When we had small coal, we got less boiler capacity than with large coal, unless we ran a thin fire and fired often; and if the coal was too small, we couldn't carry thin enough to get capacity without pulling holes. We had some washed coal, too, that gave good capacity, but it was hard to avoid smoking and didn't seem worth the extra cost for our boilers.

We didn't try anthracite, for that is out of our field, but I looked it up to see if it would work. We burn from 25 to 40 lb. of coal per square foot of grate per hour, and, of course, use a heavy draft at the high rates. Well, for anthracite of the small steam sizes, Nos. 2 and 3 buckwheat, we couldn't burn over 12 to 15 lb. per sq. ft. per hr., and our grates wouldn't do anyway. Besides, we have big deep space for combustion chambers to take care of our long flame from bituminous, and they would waste a lot of heat if we tried to use the short flame anthracite. I found that we had about a square foot of grate for 5 b.hp., while for anthracite we ought to have a square foot for 3 b.hp., and the bars with smaller air spaces to keep the coal from falling through and too much air from coming up to the fire.

I got to trying different ways of firing, too, and I found these ideas worked out well. They were some I got partly from the chief and partly from books and journals. I keep every bit of the grate covered with an even fire, no holes or humps, and clean out ashes and clinkers often enough to have good air passage. I clean clear back to the bridge wall, so as to have plenty of air come up there to burn the smoke from the green coal as it is fired. We fire "little and often," first one side then the other, and put a little more on front than back, then push it back before firing again. It's a kind of cross between alternate and coking firing and seems to work fine with our coal and grates. We keep clinkers off the side and bridge walls, too, so we can clean and fire easily right out to the edge and not have any dead space or air leaks there.

Of course, when the load gets heavy, we have to thicken up the fire and open the damper, but we look out not to get on so much coal as to make the air drag hard and the fire act dead.

We found, too, that regulating that damper had a lot to do with the coal we had to shovel. Our chimney was built to carry the gases well up above the buildings around the plant. The factory is near a lot of residence blocks, and the boss was afraid the people might kick, so he carried that chimney up 175 ft. Now, that gives us more draft than we need, and when the damper gets open too wide, that furnace roars away and eats coal like a hungry 10-year-old. And the heat "goes up the chimney just the same." The chimney is big enough so that 50 ft. less would have answered, but the folks around don't get any gas or smoke so the boss is happy; and we watch the damper. It takes about 0.8 in. of water column to keep us going right on an average load and 1 in. when she's pulling heavy, so we fixed up a U-tube and connected it by a ½-in. pipe to the chimney base and now we keep the damper so the draft gage shows right for the load, and she fires easy.

Our chimney was built square to fit into the corner between the factory and plant. It isn't as good as a round one but it gets along all right, and so long as we keep our tubes clean and treat our water right to keep out scale, we get about 7.5 lb. of water to a pound of coal, so I don't think we're making such a bad showing, or letting much of that thousand-year-old coal burn up for nothing.

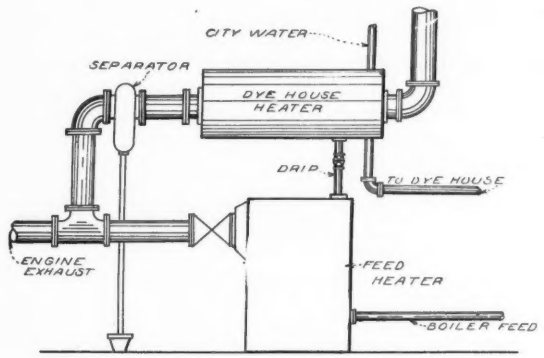
We did have some trouble with leaky tubes, until one day when I was cleaning the boiler I looked over the feed inlet and found the water discharging near the front head from a straight nipple. That didn't seem good, for though we have a feed heater, we use so much exhaust steam around the works that we get only 150 deg. or so feed temperature, and the boiler at 100 lb. is about 338 deg. So we measured up, and the next time we cleaned, had the pipe ready to run the feed inlet back near the back head, then across and turned the end down on the other side near the shell. That stopped the leaky tube ends, and she seemed to steam easier afterwards.

THE TENSION of an airplane guy wire can be determined accurately from its rate of vibration.—The Gas Engine.

CRESCENT TOOL CO., of Jamestown, N. Y., is preparing plans for a power station and concrete coal storage bins. The equipment will include a 1000-kw. steam turbo-generator unit, and boilers to correspond, also a 1500-hp. gas producer to supply gas engines, forges, and furnaces.

An Unusual Installation of Water Heaters

In a large textile and finishing plant, the engineer was confronted with a problem of heating water for two different purposes, boiler feed and for industrial work. Plenty of exhaust steam was available to accomplish the heating, though the presence of oil in this steam, even though it made itself known in only minute quantities in the heated water, precluded the use of this steam in an open heater for the industrial water. For the boiler feed service, the open heater was entirely satisfactory and possessed considerable advantages, so the proposition was finally solved by means of an installation as shown in the sketch. The exhaust steam was piped to the open heater for heating the boiler feed supply, and then any excess steam not required for this work went through a bypass to a closed type of heater through which the dyehouse water was passed. The open heater was provided with its own oil separator, hence another independent separator was placed on the steam main to the closed heater so that the steam condensed in effecting the heating in this heater could be drained back to the open heater to form a part of the boiler feed supply. This arrangement proved to be entirely satisfactory in every respect and could doubtless be utilized in many cases where two or more sources of water supply are heated.



ARRANGEMENT OF WATER HEATERS

M. A. Saller.

Carelessness

If "father" lost a leg or an arm while saving someone's life, while performing an act of heroism, for stopping a runaway engine or in the proper discharge of his duties it would be something to be proud of, and would be a mark of distinction. His wife and children would share in his glory, would never tire of telling "what father did."

But suppose he lost it through his own carelessness. Through disobeying a rule made purposely for preventing just such catastrophe, through neglect to see that all the safety devices in his care were kept in proper working order. Would that stump of arm or leg of his be a mark of distinction? Would his wife and children share in that sort of glory, and would they tell the story with feelings of pride?

Perhaps you haven't a wife and children yet. Very well. Do you think your chances for getting "the only girl" are going to be enhanced by losing a useful part of your anatomy? Do you think that it is worth while to "guess" that, because the safety valve popped off last week at some pressure above that which is supposed to be the safe limit, it is free and in working order now? Wouldn't it be better to test it every day to make sure? Do you think that stump of an arm is going to be any honor when it becomes known that you were injured by having your sleeve caught in those gears which you had been repairing, but did not take time to replace the guards before starting up when the work was completed?

Do you feel that because the state or city in which you earn your living may be lax in proving the skill and ability of those whom it trusts to have charge of steam boilers and engines within its boundaries, through lack of proper laws, that there is any excuse for your not using every known precaution to guard against accident to the machinery in your plant, and which may be the direct cause of that stump of yours or of one of your fellow workmen?

Would that improve your chances of getting "the only girl"? I think not. And yet, that is one of the responsibilities which devolve upon you when you take charge of a power plant.

We all make mistakes at times, but should not make the same mistake twice. We learn by experience. Accidents are bound to happen in the best of plants, and some of them may be serious, but it is our duty as engineers; it is our duty as men who have been trained, examined and found proficient in this line of work; as men who have a direct knowledge of the conditions and dangers that are ever present, to use every possible precaution; to see that every device installed to protect the machinery and its operators against accidents is at all times in a safe working condition, and ready for instant use in case of emergency. There are instances in which, if the board of examiners knew how the engineer misused his professional knowledge in his everyday work, his license would be revoked instantly, and for

good reason. These engineers, however, are not getting up the ladder of success very fast.

It is true that at times these safety precautions interfere with the rush of work. The few moments' extra time required to replace those belt guards after repairing the belt may mean a few dollars lost in the output of the mill, or other inconveniences, but that is no reason for their being left off until the end of the day or week before being replaced. It requires only about three seconds of time to have an arm or leg torn off by a belt, and if the men have been depending on that guard to keep them out of danger they will expect it to be there all the time, and accidents are more likely to happen during its temporary absence.

At the present time every mill and shop in the country is rushed to the limit in supplying the needs of the hour. Everybody is speeded up to the limit, and in no part of the works is this more noticeable than in the power plant. But we should "make haste slowly." There surely is nothing to be gained by hurrying to get an hour's work done in 50 min., only to have a delay later on of 2 hr. simply because we took a chance and neglected to use those precautions for safety which under normal conditions would not have been overlooked. Safety devices must be frequently used and kept in perfect working order or they are valueless.

It is the duty of every engineer to recommend to his employer and to insist to the fullest extent of his authority on every reasonable step being taken to insure the safety of the plant. It is his duty as one who has been trained and proved competent by the proper authorities to refuse to operate any piece of machinery when his professional knowledge tells him that it is unsafe, and liable to cause serious accident. Employers frequently disagree with their engineers in this respect, simply because they do not understand those matters pertaining to engineering, and must depend upon your capability. Therefore, the responsibility is yours.

You have that arm or leg now; keep it. It stands for a job that pays, and it is worth more than any job you ever had that was lost because you refused to neglect any safe precautions or shut your eyes to danger and trusted to luck. It stands for the home you have or expect to have; it stands for comfort and happiness as a guarantee that you can do a man's work and draw a man's pay, and that you absolutely refuse to sacrifice life and limb that a few dollars may be saved through neglect to use every known means of promoting safety to yourself and to those about you, or by taking chances which you know to be dangerous. "Better be safe than sorry," is a good motto, even though it may sometime cause you to lose your job for refusing to operate defective machinery.

There is always a place open to the man who can and does demonstrate his ability and skill in anticipating and eliminating as far as possible that which may mean serious injury or loss of life and property.

J. C. HAWKINS.

Criticism of Tandem Compound Engine Cards

IN ANSWER to H. M., page 105, Jan. 15, I make the following suggestions, but would like to know from what make of engine these cards were taken. I think, however, this is a Skinner engine.

The head end high-pressure admission is too late; the piston started well on its way before the steam valve was open.

The expansion line shows too early cutoff, as it drops below the exhaust pressure at the end of the stroke.

Compression line shows there is little or no compression. The crank end high-pressure card is not as bad as it looks. A little more compression and little earlier admission will straighten this out.

At present, the crank end is doing nearly all the work.

It looks to me as if the eccentric had slipped, as all events are late. The compression line for the low-pressure cylinder is below the atmospheric line; but I think if H. M. will make the change I have suggested to the high-pressure cylinder, the low-pressure will come out all right.

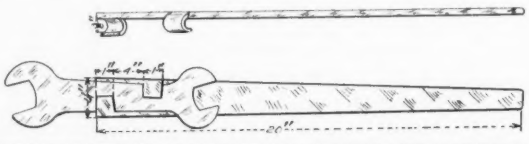
I wish, however, that before H. M. makes any change in the valve he would make sure the eccentric has not slipped.

I should like to hear how he comes out on this.

FRANK WELLS.

Extension Handle for Wrenches

HAVING NOTICED a 110-lb. engineer beating up a solid wrench with a 10-lb. sledge on some 1¼-in. cylinder head bolts, I designed an extension handle for double or single end solid wrenches. It can be made for a large wrench and will fit several wrenches of a smaller size. I have used one and they are very handy and no harder to



REMOVABLE WRENCH HANDLE AND METHOD OF APPLYING IT

use than a one-piece wrench. A man has to use good judgment with one, as with the greater leverage it is sometimes easy to strain or break a bolt. T. B.

Criticism of Nordberg Engine Cards

REFERRING TO the cards from Nordberg engine for criticism over signature of G. D., page 982, of the December 15 issue, these are well arranged—that is, the head end and crank end are separately drawn and then the two are superimposed. This latter arrangement is convenient in making a check as against simultaneous pressures on the exhaust and steam sides of the piston at any point in the stroke.

The cutoff on the crank end appears to be less than that on the head end, while at the same time the point of cutoff is not well defined, which might be due to a steam valve being sluggish in closing, possibly caused by slow dashpot action.

On the other hand, the cutoff point on the head end is well defined. From indicator cards which I have taken on Corliss engines, I have generally discovered a knock at the pin with the slight amount of compression shown on these cards.

The principal item for criticism is the excessive back pressure, which from the form of the line could not be

caused by the use of exhaust steam for heating purposes. There is a pronounced hump in the head end card. In checking this point back against the steam side of the piston, it fails to offer a solution, as there is no apparent drop in pressure. I think it would be well for G. D. to take these cards and draw on them a theoretical expansion curve, as the head end one appears rather full. It is possible that the points of excessive pressure in the back pressure line may be caused by a sluggish exhaust valve, or one that opens too slowly to permit the escape of the steam without accumulating pressure. With 120 r.p.m. and a 36-in. stroke, there would be a comparatively high piston speed—720 ft. per minute—and it is necessary that the exhaust steam be disposed of promptly. I suggest that he remove the bonnet from the exhaust valves, revolve the engine slowly and note the per cent of opening of the exhaust port in connection with the amount of the crosshead movement and the amount where hump occurs in the back pressure line.

It is barely possible that this engine is fitted with independent driven exhaust valves not operated through a wristplate. If these valves are operated through the medium of a wristplate, a proper adjustment of the rods or the crank on the valve stem will result in a quicker action of the valve in its initial opening movement.

W. O. Moody.

Washer Drill

For cleaning out the tubes of our boilers with kerosene to cut out the stubborn grease that somehow got there, we made swabs out of canvas washers slipped on a rod, as shown in Fig. 2. To make these washers, a drill as shown in Fig. 1 was devised. This was operated at high speed. Many layers of canvas were tacked

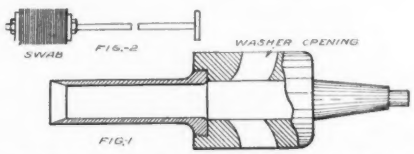


FIG. 1. SECTION OF DRILL USED TO CUT CANVAS WASHERS
FIG. 2. WASHERS ASSEMBLED ON SWAB

to a board and drilled at once. Two sizes of drills were made, one for the inner and the other for the outer diameters.

Chas. H. Willey.

Gunpowder to Clean Chimneys

A previous article on this method of cleaning chimneys reminds me of a railroad pump house engineer who always cleaned his flues with gunpowder. He, however, did not have the method worked down to a science such as Mr. Russell uses. He would send his helper for 10 cents worth of gunpowder, place it in the firebox (when the boiler was cold, of course), make a "time fuse" out of a newspaper and then "beat it" after closing all doors tightly. I was a youngster at the time I witnessed these performances and was greatly interested. I enjoyed watching the fat engineer run for a safe place.

When a man runs away from something he is doing you can rest assured that he isn't very positive as to just what is going to happen. In blasting rock, men don't have to run any more. It has become more of a science than that. And I imagine Mr. Russell doesn't run either when he cleans his chimneys.

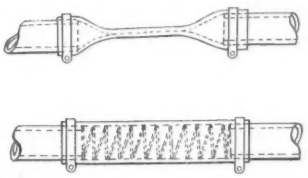
Later in life, I took a course in engineering and in "Steam Boilers," as one of the studies was called, the professor asked me how flues were cleaned. I told him that gunpowder was sometimes used. The professor then worked up a bit of a rage because he thought I was trying to "bluff 'er through." He was sure I hadn't studied my lesson. After he had finished lecturing me for being so ignorant, I continued my story and recited the methods of flue cleaning given in the text book.

Evidently the pump man was considerably in advance of the times—in a clumsy way.

N. G. Near.

Avoiding Collapse of Hose

To eliminate much trouble frequently encountered by operators where all or a portion of the suction line of a pump is made up of hose and for some reason or other the supply at times fails, I have employed the scheme indicated in the accompanying illustration. Under such conditions, the hose, due to the action of the



SHOWING HOSE WITHOUT AND WITH SPRING INSERTED

pump, will collapse and will not again assume its natural shape until the pump is stopped. If, however, a coil spring is inserted as shown this cannot occur.

C. C. Spreen.

Some Odd Experiences

At one time my attention was called to a clicking noise in a steam engine cylinder. At first it was thought that the packing ring springs were loose or some broken, or the packing ring had too much play between bull ring and follower plate, or it was broken; but upon examining these parts, nothing was found wrong, so the engine was kept in operation for some time with the clicking noise in the cylinder. During the meantime, it was decided to get some outside help to locate the cause of the noise.

Before doing this, I decided to take a few indicator cards, which may give some hint as to where the trouble lay. After making all arrangements, when about to blow-out the indicator piping of dirt and other matter, I noticed that one of the angle valves located at each end of the cylinder was partly open; after closing this, to my surprise, the noise in the cylinder disappeared. The cause of the trouble evidently was that, as the indicator piping is equipped with angle valves at each end of the cylinder and a 3-way indicator cock in the center, and by mistake one of the angle valves was opened partly and the disc caused the clicking noise (as usually a valve disc has some loose motion on the stem). The cause of the noise was very simple, and

then it was found accidentally, as nobody ever thought of the valve being open.

In another instance, while making repairs on a boiler feed pump such as new valve seats at water end and repacking water piston, after the pump was in service a short time it was observed that it did not furnish as much water as before repairs were made. It was thought that the water valves or piston leaked, but this was not the case. The pump had to run at a much higher speed to furnish sufficient water to the boilers. In the meantime, efforts to locate the trouble were made, but no relief was forthcoming. Shortly after this the gasket let go between the water cylinder and valve plate or false seat, as it is sometimes called. After removing this for placing a new gasket, the cause of our trouble was found, as one of the water valve spring nuts was located next to the discharge pipe opening at water cylinder nearly closing the hole, the nut being of the hexagon type and the diameter about 1⅝ in., while the opening in the discharge is 1½ in.

At another time, a boiler feed pump gave much trouble, which was due to lack of inspection, or, in other words, everybody was satisfied as 'long as the machinery would operate although with much delay and trouble as is the practice in some plants.

This pump failed to furnish water in the boiler one day. Upon examination it was found that the water piston packing had disappeared. This was replaced, but after a few days' service this also disappeared. This was a puzzle; the packing was replaced again, but to disappear after short service, then the water piston was removed when the trouble was found; the brass water cylinder lining was worn through in the middle of the cylinder at the bottom which, of course, cut the packing to pieces in a short time. This was not noticed, for when the piston was replaced, it was shoved as far as possible to the back opening of the cylinder so as to enter the packing. In this case, much trouble and worry could have been avoided if the cylinder had been inspected long before this occurred, as now the pump had to lie idle until a new liner was gotten.

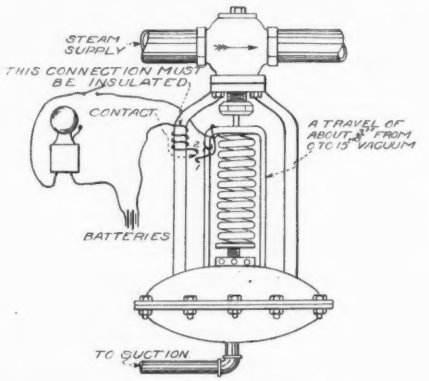
An electric traveling crane, driven by a direct-current motor, started to give trouble by not starting at times and when it did start it did so with a jerk. Upon examination nothing could be found materially out of order; but, to satisfy myself, I told the crane operator to try to start the motor while I kept a close watch on it. I soon found that when the motor did start, in taking up the load, the shaft and armature would rise up nearly against the top field coil, then after the motor would stop, the shaft and armature would drop to the lower position, but the top brushes would not follow the commutator but kept hanging away. The brushes had too tight a fit in their holders or dirt held them, but most of the trouble was caused by the bearings being worn badly which allowed the armature and shaft to rise. This was not noticed, due to the old hard grease around the shaft and bearings, as there was very little clearance between armature and field coils. Providing new bearings and giving the brushes more play in their holders cured the trouble.

An extension was made in the runway of an electric traveling crane one Sunday; the trolley wires were lengthened the distance of the extension. When the crane was started on Monday morning the trolley wheels sparked so badly that the crane would barely move. This was a puzzle to me, as the crane did not behave this way at any time before. The wiring was looked over but was O. K. Then I got an idea where the trouble must lie and told the operator to run the crane on to the new part of the runway, when there was no sparking. In looking over the old trolley wires, I found that these had been turned upside down; in drawing up the wire at the ends of the runway, the old wire was turned; as this had been in service for many years, much dirt had collected on it, so there was very little contact between the trolley wire and wheels. Sandpapering the wire cured the trouble, as it could not be turned to bring it into the old position again.

H. A. JAHNKE.

Alarm for Vacuum Pump

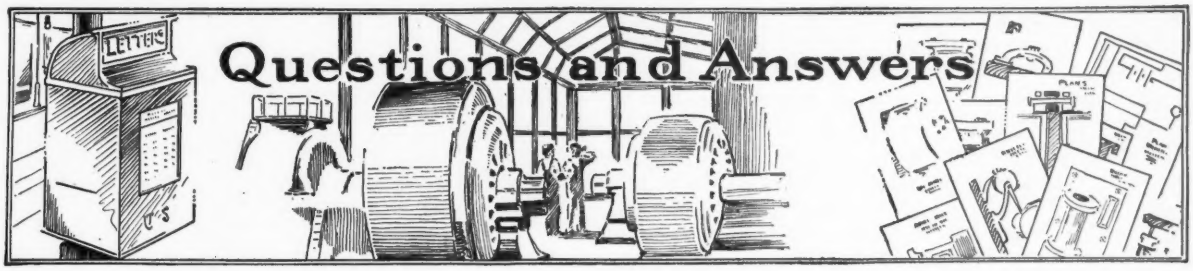
HEREWITH is a sketch of an alarm which I have attached to a vacuum pump governor and it is of great assistance to me. Considerable trouble was experienced with our vacuum pump, which was badly in need of a general overhauling. Our load was by no means steady and the temperature of our returns varied with the load. At times when they were too hot the pump would stick and always remained stopped long enough to allow the receiver on the boiler feed pump to run dry and the cooling water for the returns would run about halfway back up in the heating system. As the outside temperature had been below zero for a couple of weeks and no signs of relief in sight, the only way of handling our returns was through this pump, so I attached the alarm as shown, which entirely overcame the latter troubles and operated as follows:



PUMP GOVERNOR ALARM

With two pieces of No. 14 B. & S. rubber-covered wires about 8 or 10 in. long, one twisted around the yoke of the governor so as to make it rigid and the other twisted around the frame as shown, failure in the pump's operation would allow the tension of the spring to overcome the vacuum, thus closing the bell circuit at 1 and 2. Care must be taken to insulate one of the connections. A switch may be placed in the circuit so as to cut out alarm while the pump is being started. With a little time and patience, a permanent hitch may be made; but as we have repaired the pump, it has been on good behavior since.

JOHN J. DINNEEN.



Pounding Engine Bearings

WHAT ARE the principal causes of pounding in engine bearings? How may this be remedied?

SUBSCRIBER.

A—The principal cause of pounding in engine bearings is lack of adjustment to compensate for wear. No matter how profuse the lubrication may be, or the quality of it, wear naturally occurs and adjustments must be made from time to time. And if this important matter be neglected, the wear becomes more rapid. On the other hand, one should not be continually tinkering with engine bearings as some engineers are prone to do.

If an engine is properly erected, the shaft will be square with the centerline of the engine; and if the bearings are properly adjusted, the engine should operate quietly excepting, of course, that the setting of the valves is such as to preclude quiet running.

There are many engines in operation today which were built in such a manner that correct adjustment is impossible. Reference is made to the early designs of Corliss and other large horizontal engines which had a rigid outboard bearing grouted in place, and a main bearing with adjusting device on one side only—usually the front side.

As the main bearing wears, adjustment is made from time to time, which naturally crowds the shaft toward the cylinder, but as the outboard bearing cannot be adjusted to compensate for the wear in the main bearing, the shaft will soon get out of square. With an engine of this design, the shaft should be squared up and shims added behind the rear quarter box so as to hold the shaft in the same position as it was when erected. Should the engine be belted forward, the wear on the outboard bearing will be in the same direction, continually, while the rear quarter box of the main bearing will have its usual wear owing to the intermittent thrust of the piston. This arrangement soon throws the engine out considerable with consequent pounding.

When the shaft is out of square, the crankpin and crosshead pin boxes will slap from side to side, causing noise, and a continuance of this will cause the brasses to wear in the rod ends and even after the shaft has been squared up, these boxes will continue to pound unless shimmed up. Shimming strips may be sweated onto these boxes, or, if the wear is so small that very thin shims must be used, plane off 1/8 or 1/16 in. and sweat on a piece of brass of like thickness and scrape to a perfect fit.

Of late years, engine builders have paid more attention to engine adjustment and the main and outboard bearings are usually provided with adjustment both ways from the squared center line of the shaft. Sometimes the main or outboard bearing, or both, are provided with a bottom wedge adjustment.

Still, to some engineers, such features are a detriment rather than a benfit, for many overlook the reason for these refinements and adjust at random, really exaggerating their troubles.

The writer having spent several years erecting engines, made it a rule before leaving the job, to provide the engineer with some form of marks to insure continued perfection of the original adjustments. One method was to scribe around the collar on the inside of the main bearing with a sharp scriber, which mark extended beyond the wedges, etc., onto the frames and so were permanent. By adjusting the wedges for wear, one had but to keep tab on the scriber mark and adjust to keep the shaft concentric with it. Should the shaft wear low, it would be necessary to insert thin metal shims under the lower shell to raise the shaft to its original place.

With the outboard bearing, a sharp chisel mark where the bearing rests on the stationary sole plate provides a permanent mark for reference. If the outboard bearing wears low more than the main bearing (which is unusual), shims may be added as required.

Then there is a cause for pounding, little understood, and in fact, ignored by many good engineers as a probable cause, more than is generally expected, and that is loose babbit. How frequently we see bearing shells which have been melted out for rebabbiting, where the anchor holes are but an ordinary drilled hole of small diameter drilled not more than the diameter of the hole in depth. Such a method cannot be criticised too severely. If for any reason anchor holes or slots are not cast in the shell, and it is necessary to drill them, the holes should be comparatively large in diameter and depth, if the stock will stand it. Let us suppose an instance where the shaft is, say, 12 in. in diameter, and that the slot cores "fell out" when casting, thus leaving the shell wholly or partially devoid of any method of holding the babbit. Anchor holes should be at least 3/4 in. in diameter and fully as deep, and at the bottom, holes about 3/8 in. should be drilled at an angle so as to form a "root" to the babbit as it fills these holes.

These large holes should be spaced not more than 2 in. apart and should be slightly countersunk at the top so as to not leave a sharp edge in which case the anchor may easily break off causing loose babbit which with a little care might be made perfectly solid.

The writer once dismantled, rebuilt and re-erected, a Corliss engine in which the babbit was loose in every bearing and pin box, as well as three out of four cross-

head shoes. The anchor slots were conspicuously lacking, enough being present in places to show that the cores had "fallen in."

To hold the babbit, holes about 3/8 in. in diameter and as deep, were drilled about 3 in. apart, both in the main bearing shells and in the crosshead shoes, and a 1/4-in. flat head screw tapped in at each corner as an additional "anchor," while the brasses were drilled scarcely 1/4 in. deep, the entire job indicating that the manufacturer thought it "would hold till they got their money."

The fourth crosshead shoe was melted out just for spite, and though the anchors were a little better than at other places, yet they would eventually give out and permit the babbit to become loose; and besides, it is easier to turn a crosshead and make a "job" of it with both shoes re-babbited. Anchor holes were drilled as described above, and after re-babbiting, the babbit was thoroughly peened with a 3-lb. hammer, after which the parts were turned or bored as required. This engine has now been in service in its new location several years, and without any evidence of loose babbit.

A crosshead shoe will become loose, especially if it be the non-adjustable kind and cause pounding.

If the retaining screws become loose, the shoe is not gripped tightly and the continued reversal of motion soon causes a little lost motion which rapidly grows. If allowed to become too bad, machine off where wear has occurred and rivet on a steel shim, afterwards refitting the parts snugly and renewing the bolts attaching shoe to crosshead, using a size necessary to make a good job of it.

Lateral motion of the shaft is one cause of an annoying pound in the main bearings of engines. It is necessary to have at least some play here, but occasionally it is too much. Sometimes a wobbling wheel will cause lateral motion, or a wide band wheel which, though it may balance perfectly could it be tested on a gigantic balancing roll, might be heavier on one side of the rim than the other, this defect in the two halves of the wheel being on opposite sides of the rim. Sometimes it is impossible to cast a wheel which is symmetrical in all its proportions.

If the engine have a generator on the shaft, it is possible to have the stator so perfectly set that the rotor moves in practically a neutral path and no magnetic influence is present to hold the shaft steady either against the crank or the collar. The remedy in a case like this is to move the stator laterally, preferably away from the main bearing, a small amount, in which case the magnetic influence will hold the crank against the bearing.

If the shaft be moved too far, the thrust of the crank against the bearing will be so great as to cause heating which will send the attendant off on a blind chase of a tight bearing, poor oil, or something else, besides interfering somewhat with the electrical output.

Then, as referred to above, though the bearings may be in perfect adjustment and lubricated with the greatest care, the valve setting may be such that the reversal of the reciprocating parts may be too sudden, thus causing a knock or pound even when the adjustment is close.

Of course, there are many engineers who are ardent admirers of little or no compression in cylinders and who can product coal records to prove their assertions; but there are exceptions to every rule and in the writer's opinion, such cases are exceptions to a general rule, that compression is necessary for quiet running to a greater or less degree, depending on operating conditions.

Valves should be so adjusted that compression will begin about 4 per cent of the stroke from the end, for speeds ranging from 50 to 65 or 70 r.p.m. and moderate pressures, and ranging up to 8 or 9 per cent for speeds as high as 150 or 175 r.p.m. and higher pressures for Corliss or other similar engines.

For single-valve, or double-valve high-speed engines, the compression may even begin as early as half stroke while in the uniflow engine now coming into prominence, compression begins soon after the piston starts on the return stroke; in fact, so early that when running non-condensing part of the steam must be released at the end of the stroke through an auxiliary valve.

G. H. WALLACE.

Effect of Soda Ash and Caustic Soda

WHAT ARE the objections, if any, to using soda ash and caustic soda as a boiler compound?

What may be the effect on valves and cylinders of the engine?

Is it likely to cause a sediment to be carried from the boiler with the steam, which may cause steam traps and small piping to become stopped up unless the boiler should prime?

About what quantity of soda ash and caustic soda would you recommend using?

Our feed water is very hard, or, in other words, it contains considerable lime. E. McK.

A. There is no objection to the use of soda ash or a boiler compound. The caustic soda is also useful, but needs to be handled with some discretion, as overdoses may result in pitting.

There is no danger of carrying over solids, from the use of either of these materials, into the engine or piping, so long as no more is used than is necessary to counteract the scale-forming material in the feed water.

As to your last question, it is entirely impossible to say what proportion of chemicals should be used without knowing exactly the amount of scale-forming material in the water. Guesswork is worse than nothing. The only proper way to handle this is to have the feed water analyzed by some competent chemist, who will tell you exactly the proportions of soda ash and caustic soda to use in order to get proper results.

Steam Calculations

WILL YOU kindly give me the correct way to figure the factor of evaporation when the steam is superheated?

Should the degrees of superheat be added to the total heat as given in a table of saturated steam?

C. E. C.

A. The factor of evaporation for superheated steam will be the total heat of saturated steam plus the heat due to superheating, minus the heat of the liquid at feed-water temperature, and the remainder divided by 970.4.

It is rather difficult to figure the heat of superheating without a table of the properties of superheated steam, as the specific heat of superheated steam varies with the pressure and the number of degrees of superheat.

The only easy way to figure the factor of evaporation would be by the use of a table of properties of superheated steam, which gives you directly the entire amount of steam in a pound for the conditions specified.

For instance, at 120 lb. absolute and 100 deg. superheat, giving a total temperature of 441.1 deg. F., the total heat in the superheated steam is 1244.1 B.t.u. If the feed water is supplied at 160 deg., there will be 127.86 heat units in the liquid; the difference will be 1116.24, and if we divide this by 970.4, we get practically 1.149 as the factor of evaporation.

CO_2 Analyzer Questions

How is the percentage of CO_2 read on the burrette of a CO_2 analyzer?

2. What is the solution used in the pipette?

3. What amount is used?

4. Is the exhaust end of the pipette open or has it a gas bag? E. G. M.

ANSWERS

IN THE OPERATION of the Orsat CO_2 analyzer, the sample to be analyzed is first measured in the burrette. It is then passed through the absorption pipettes, and after that again caused to enter the burrette and a second reading taken. The original reading indicates this volume of the gas being measured, and the second reading indicates this volume minus the CO_2 removed.

In order to determine, therefore, the percentage of CO_2, it is necessary to multiply the quotient obtained by dividing the original volume by the loss, times 100. This will give you the percentage of CO_2.

2. For absorbing CO_2, a solution of one part of potassic hydrate (K O H) or caustic potash dissolved in 2 parts by weight of water is generally used.

3. The answer to this question is embodied in answer to Question 2.

4. Soft, rubber bags are generally attached, by means of glass tubes, to corks in the pipettes, on the farther side, and are provided to protect the reagents from absorbing oxygen and carbonic oxide from the air. These rubber bags are also useful for the purpose of producing, alternately, with the pressure of the hand, suction and pressure for agitating the reagents.

Saving Due to Pipe Covering

I HAVE one 100-hp. engine connected with 5-in. steam pipe about 100 ft. from the boiler, also a 25-hp. engine connected with 2½-in. pipe and about 20 ft. of pipe. Steam pressure, 100 lb. Both connecting pipes are unprotected, in open shed, with good roof. The boiler is of the return tubular type set in brick and is rated at 125 hp.

Please advise what the waste is over what it would be if the pipes were properly protected. Coal costs $5.50 per ton at boiler.

Also please advise if a box made of plank packed with sawdust, 4 in. on all sides from the pipes to the box, will prove to be efficient. B. W.

A. With reference to the covering which you desire to place over the 2½-in. pipe connecting your engine with the 100-hp. boiler of your plant, we would hardly advise using sawdust for this purpose. The standard covering used for work of this kind, which we would recommend to you consists of about 85 per cent carbonate of magnesia mixed with about 15 per cent of asbestos.

For first-class work, the thickness for high-pressure pipes, such as those carrying steam under pressure of 100 lb. and more, we would advise about 2½ in. of this covering, thus calling for a casing having a minimum external diameter of 7½ in.

The actual saving which you would realize by any kind of covering could only be determined by conducting a careful test on your plant, first, with the pipe bare and then with the covering applied, and noting the difference in steam consumption. We would, however, be safe in saying that the saving depends entirely upon the covering employed and may range from 65 to 85 per cent and higher.

You will, of course, understand that when we make this statement we do not mean that the saving at your coal pile will be 65 to 85 per cent of your present coal consumption, but that the saving referred to is the reduction in loss of heat due to condensation in this length of pipe.

Effect ot Electrolyis

WILL direct or alternating current cause corrosion of underground water pipes? SUBSCRIBER.

A. Tests made to determine whether alternating currents have tendency toward electrolytic action in water pipe show that they do. The extent of such action is, however, less than 1 per cent of that which would be produced by a corresponding direct current.

Soot Problem

I HAVE a Kewanee flue boiler equipped with a downdraft furnace used for heating an apartment building. A vapor heating system is employed, consequently the pressure and temperature are comparatively low. We are using Franklin Co., Ill., coal which has an analysis as follows: Moisture, 2.59 per cent; volatile combustible, 29.21; fixed carbon, 49.75; ash, 8.45; sulphur, 0.85; heat value, 13,515 B.t.u. per lb.

I would like to hear from readers of Power Plant Engineering how I can prevent the deposit and consequent baking of soot in the tubes. This scale cannot be removed with a flue blower, and a flue brush or scraper does not give satisfactory results, apparently nothing but a turbine tube cleaner will cut the scale and we are not equipped with this. The scale seems to be mostly carbon mixed with enough tar and ash to bind it into a cementlike scale, when cold, which accumulates rapidly, necessitating frequent shut-downs for cleaning. Do readers who have had similar experiences have any suggestions which will aid in operating this boiler? E. R.

Question for Readers

ONE OF the engine cylinders in my plant has worn large at both ends of the stroke—considerably larger than in the center. Can anyone offer an explanation of this? J. D. C.

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Wild Horsepower

Horsepower wild is as useless as horses wild. Yet we have let and are letting millions of horsepower go rushing down our rivers with no concerted effort to harness them. The matter is before Congress of providing legislation that shall encourage the putting of this energy to work, and the Chamber of Commerce of the United States is sending out a set of recommendations, for approval by its members, as to what this legislation should embody.

Briefly summarized these provisions are: That such legislation should be at once enacted, in such form that a separate act will not be needed for each development, but permits may be issued by some department or commission under conditions protecting the interest of the public and the investor. Permits should be for at least 50 yr. unless a shorter time is agreed upon by the applicant, irrevocable except for cause, and tolls should be imposed only on developments on the public domain or benefited by government head-water improvements; the tolls should be reasonable, proportionate to benefits derived, and based on power actually developed, used and sold.

At expiration of the permit, the government should have the right to retake the property for itself or a new licensee on payment of just compensation for the property and for dependent property or for damage to dependent property because of the government action. The first licensee should have priority over a new applicant, other things being equal. The government should agree on terms for a new period, continue the old terms, or retake the property for a new licensee.

For service within a state, the state commission should regulate rates and service. Only where there is no state commission, or those commissions cannot agree, or where the service is interstate, should federal authority regulate. Federal control of issuance of securities is deemed unnecessary and unwise.

All applicants, municipal or otherwise, should be on the same basis, with no grant or subsidy which will create unequal competition.

Undeveloped water power of the country is estimated to exceed the total steam power in service, but the policy of the government in recent years has been such as almost to prohibit development. Such developments require large investment per horsepower of capacity as compared to a steam plant, and are not, as is thought by some, exceedingly profitable undertakings. The advantage lies in the smaller maintenance cost and no cost for fuel, but fixed charges are much heavier for the water power plant.

Benefits from the development of a water power are usually as great to the community as to the investor, hence it is to the advantage of the community that such development be encouraged and made attractive, to secure the conservation of the wasted wild horsepower at as early a date as possible.

Welding Repairs

Welding of broken parts by the oxy-acetylene process has provided a means of repair that is found of constantly increasing value. For all but the smallest and simplest pieces, the expense is usually less than by any

other method or the replacement, and much time and labor are saved by not having to wait to send the part away for repair and frequently by avoiding dismantling a machine.

Many readers must have had or be having interesting experiences in the use of this method. It is a job that might naturally fall to the engine room repair force, especially where the chief engineer also acts as master mechanic for the plant.

In this issue, one writer tells of the uses he has made of his outfit. We feel sure that all readers will be interested in other detailed information showing just how specific jobs have been done. We trust much such information will be forthcoming.

Business and the War

By Governor Frank O. Lowden, an Address Before the Editorial Conference, Chicago Trade Press

IT is a great pleasure, and a great inspiration to be at this luncheon. Everyone who has had any activity in business or professional life has long known of the power, if they sought to exercise it, of the business press.

There is not a business paper represented here today that does not reach its reader at a time when his thought is serious; at a time when he is looking not for entertainment, but only for instruction. And I am delighted to know that the representatives of this great power have formed an organization and are working in concert.

All who are familiar with the history of trade journalism in this country know that its editorial columns are not controlled by its advertisers, but speak the conscience and convictions of its editors.

This leads me to the observation that business learned years ago that to attain the highest success, it was necessary to have the highest integrity; business learned that the old practices of trickery were not the practices which resulted in the largest business success.

The next great development along the line of honesty will be when the governments of the earth learn that the wisest diplomacy is honest diplomacy; when the governments of the earth shall learn that to plant spies in the midst of a foreign and friendly people is to plant the seeds of future disaster; when diplomacy shall be conducted in the sunlight of truth and candor, and no longer requires treachery and deceit. Of course that idea has gained ground in our own country. And we owe that to the lessons which the business man taught us; we learned that frankness was as compatible with success in negotiations as it was with success in any other field of human activity.

Of course, this idea has not gained great headway of late years, because, as a shadow above all the earth has been the other idea, which had its inception half a century ago in Germany, and which was that the state is above the moral law; that with state might is right, and the only argument which can be heard is the cannon. That idea expanded and expanded until it threatened the peace of all the world, until it resulted in this war in which we now find ourselves engaged, in which every nation aspiring to the higher ideals of the moral obligation of the state, to the higher ideal that among states, as among individuals, right is everlastingly might. In the far away crisis today, we are giving our blood and treasure to make triumph forever and forevermore, that noble idea of the equality of the state.

Another thought that has come to me as I have been sitting here, is the fact that this great war, among its other compensations, is bringing great trades and industries of this country closer together than they ever were before.

In the stress of this great war, you are finding that the highest good of every industry is linked with the highest good of every other industry; you now sit about the same table and you deliberate together, for that good, which shall fall as the dew from heaven upon all. That is the best gain.

Let me tell you another gain that will come before the war is over. Employer and employe are going to have a better understanding of one another. The employer and employe are going to realize, and must realize, that they are employed in the common enterprise, and that if success in the great work of reorganization which shall succeed this war, shall come to industry, that they must act as partners in business.

I read not long ago a book written by an English soldier, a soldier of high education, a soldier who belonged to a family of wealth. He was serving in the ranks, and said, at the close of his most impressive chapter, that when he stood in the trenches with the men who worked, side by side, when you incurred the common peril that came to both, he could not think of any fight with the workingman when he returned home.

Our country was founded on the doctrine of democracy; we were the first great democracy of the world. But before the war came we were getting away from the democracy of our fathers. The industrial age, great as it is, brought new problems and new perils and we became isolated one from the other. We were looking first at our own industry and then we were looking at our own difficulties, and the common good of man, which inspired the heart and nerves and arm of our fathers in every battle they fought for democracy, was being forgotten. This war is going to bring it back again.

We will not have as many young men when this war is over as we would have had without this war, but we will have a finer lot of young men with keener brains and bigger hearts and nobler aspirations than we have had in fifty years. (Applause.)

There is not anyone, man, woman or child, beneath the protection of our flag who does not want a speedy peace. Above our desires for a speedy peace, we should first resolve, and resolve again and again, that, though this war may last years, we shall be steadfast until it ends, and we will prepare ourselves for a long war.

There is only one thing, by any possibility, which can make us lose, and that is, if we shall not realize to the fullest extent what this war means. If the American people will only visualize the consequences of this war; if they will only represent to themselves what this country will be like in the event we lose,—I know the American people well enough to know that we shall win, and win triumphantly. We cannot win if we are going to foster illusions about the consequences of this conflict.

We have had great wars in the past. There are very few here who can recall the Civil War, which up to that time had been the greatest crash of arms in all the history of time. But black as the days of that war were, filled with gloom as the skies were at that time, that war was not as close to your home and mine as is this war today. And I will tell you why: If we failed in that war, whether we were of the North or South, to whichever side we belonged, if we failed in that war, all would not have been lost; we of the North and they of the South would still have had some kind of country which they could call their own; ours in the North, and theirs of the South, would have been fragmentary—inglorious, if you please,—falling far short of the glorious destiny of which our fathers at Lexington and Concord dreamed—but still there would have been some country which would have been beneath the protecting folds of our flag, some place which we could have called our home.

If this war goes against us, all is lost, and I measure my words when I say this, because when this war is over all the earth will be one thing or another: It will be under the iron heel of military despotism everywhere, or it will be free everywhere; if the war is lost there will not be room for even the littlest American flag or any other flag of liberty and freedom and humanity, but the ruthless eagles of Prussia will rule the air, and will oppress the earth.

This is not a war singly between two countries jealous of each other's territory, or envious of each other's trade; it is a war between two ideas, which have been in conflict since the dawn of time. The idea, on the one hand, that man is worthy, that man is entitled to rule himself, that man is worth living for and dying for, that just common humanity should dominate the globe. The other idea is that millions of men are only of use if they serve the masters of the state; that there is no place for them except to delve and toil in order that the few thousand men may enjoy the beauties of the universe, the right to rule, may enjoy everything beyond the drudgery of toil. Those are the two ideas that are engaged; they are the ideas which met, my friends, at Lexington and Concord. That battle has been raging ever since; once on French soil, later in Poland, and then Hungary; somewhere it has been raging from that day until this. And now the grand and final clash between these two forces has come, and the same old battle which flashed forth on the Atlantic seaboard a century and a half ago is raging around the earth. It is a battle between these two ideas, not for one country nor another, but for possession and mastery of the globe.

If anyone has any doubt about the correctness of my prevision, let him go to Bernhardi and let him read the author's Treitschke and Nietzsche, to know that when this war was opened, it was opened deliberately upon the proposition of either world dominion or downfall. It is a war which affects every liberty loving man and woman and child everywhere, for we will not have even a fragmentary country left if we lose. Think of what America has meant in the 150 years since the first shot in the war of our Revolution was fired. Think what it has meant to the downtrodden and defeated lovers of liberty in other lands.

But if this war shall go against us, there will be no quarter in all the world anywhere to receive the defeated and hapless and broken patriot who is seeking some place where, in his last hours, he might breathe the air of liberty. But, my friends, if we realize what it means, we shall have the resolution to win. In one sense the central empires have made it easy for us, because they have themselves, by their own hands, painted the future of all the world so dark that no one would care to live upon this globe one hour after an Allied defeat. They have made it easy for us.

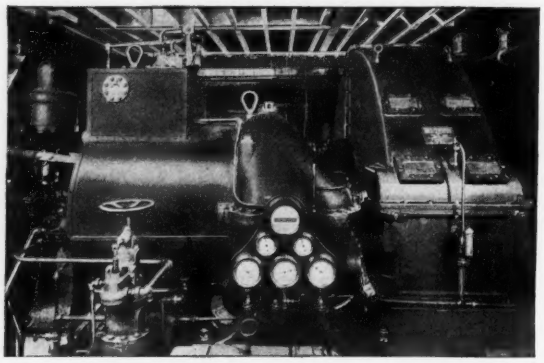
And I want to say in all soberness that the man who succumbs in this conflict in the service of his country will be infinitely happier than those of us who survive the conflict to come under the rule of despotic military forces, as we surely will.

You are helping, helping greatly, you are helping splendidly, and I thank you, ladies and gentlemen of the Business Press, for the inspiration and the help which comes from you in this great national crisis in which is involved all we are, all we have, all we hope for our children.

Geared Turbine Drives Flour Mill

A NOVEL turbine gear application has recently been made at the Northwestern Consolidated Milling Co., Minneapolis, where a 1,700-hp. Westinghouse high-pressure condensing turbine operating a 3,000-r.p.m., is geared to a flour mill shaft operating at 140 r.p.m. through a single-reduction Westinghouse gear.

In an installation where the load is practically constant day in and day out a geared turbine drive is more efficient than one which employs electricity through a



WESTINGHOUSE TURBINE (AT LEFT) DRIVING MILL THROUGH 21:1 REDUCTION GEAR (AT RIGHT)

motor. Where electric drive is employed, there will be losses in the generator, the wiring, the motor, and rope drive, the latter being necessary since the line shaft of the mill does not operate at an advantageous motor speed. On the other hand, in the geared drive the only loss is that of the gearing itself, which does not exceed two per cent.

This form of drive is also especially desirable where the floor space available is limited. In this particular

case, the turbine and gear were installed in approximately the floor space occupied by the driving pulley alone of the reciprocating engine unit which it displaced, the old engine unit requiring approximately four times the floor area which the new turbine and gear equipment occupied. The floor space was further reduced by the employment of a single reduction, the ratio between the two gears being 21:1. So large a reduction can be secured only with a Westinghouse flexible frame mounting for the pinion, which secures perfect freedom of the pinion through alining it with regard to the driven gear, thus securing uniform pressure across the entire face of the teeth in contact.

This installation includes an ideal application of a barometric condenser, inasmuch as the condenser head is bolted direct to the expansion joint on the exhaust connection of the turbine and the tail pipe drops perpendicularly to the hot well below. The water supply to this condenser is taken from above the dam at St. Anthony Falls, while the hot well is at the level of the tail race, 40 ft. lower. The injection to the condenser is about 4 ft. above the water level and a steam-operated air ejector is opened for a few seconds to start water flowing and is then closed so that the condenser operates without any pumps, either water or air.

Portable Chaingrip Vise

FOR convenient location near the work so as to save walking to a bench, this vise is well adapted. A base with 4 bolt lugs, to be used only for a semi-permanent mounting on a bench, is squared out in the form of an inverted V so that it will fit over the corner of a post or beam, or against a column. For temporary use, it is held in place by a clamp with chain and eyebolt adjustment, having a base also of V-shape to rest opposite the vise. One end of the clamping chain is fastened to one side of the base of the vise, and a link of the chain slips into a socket on the other side, the vise

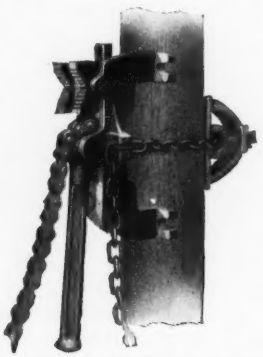


FIG. 1. CHAINGRIP VISE CLAMPED TO ROUND COLUMN; VISE UNLOCKED

being clamped solid by drawing up on the nut of the eyebolt.

Pipe or conduit is placed against the double set of steel pipe jaws and locked there by a close linked steel chain, made fast at one end to the pipe jaws and drawn up at the other end by a lever forced down by a cam on the handle. The fulcrum of the lever is adjusted by means of a knurled headed bolt to give the needed amount of force on the locking chain.

Malleable iron is used for the castings, which are heavy and durable, and steel for the jaws, locking chain and lever. The clamping chain is of wrought iron.

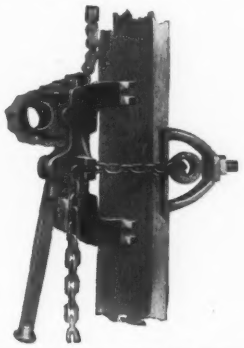


FIG. 2. VISE MOUNTED ON SQUARE POST; LOCKED ON CONDUIT

This chaingrip vise is made by the Gerolo Mfg. Co., of Chicago, in two sizes, the No. 1 for pipe from ⅛ in. to 2½ in.; No. 2 for pipe from ¼ in. to 4½ in.

Catalog Notes

IN ITS BULLETIN entitled, "Fundamentals of Illumination Design," the Engineering Department of the National Lamp Works of General Electric Co., has presented in simple and readable language a discussion of the broad principles which underlie illuminating engineer practice. It is a bulletin which should prove of exceptional value to schools and colleges, particularly to those in which a course in illumination is included as a part of the regular study program. Its value is not limited to students, however, for much of the material presented is the result of recent investigations, and the data will bear the closest scrutiny of the practicing illuminating engineer. This bulletin on the fundamentals, the bulletins on specific applications such as industrial lighting, store lighting, show-window lighting, light projection, tennis court lighting, protective lighting, etc., together with the bulletins on Mazda lamps, comprise an accurate, practical, and up-to-the-minute reference work on illumination.

THE FOLLOWING BULLETINS have been received from Mesta Machine Co., of Pittsburgh: Bulletin D, on Mesta Automatic Plate Valves; Bulletin H, Mesta Blowing Engines; Bulletin K, Gears and Rolling Mill Pinions; Bulletin Ka, Horsepower Chart for Power Transmission Machinery; Bulletin R, Mesta Barometric Condensers.

A SMALL CATALOG FOLDER describing briefly the entire line of equipment manufactured by The Griscom-Russell Co., 90 West St., New York, has just been received.

ON THE TRAIL of Byers Pipe, is the title of a booklet comprising an illustrated record of the service given by Byers' pipe in plumbing, heating and power systems installed from 25 to 40 yr. ago. The manufacturer is A. M. Byers Co., Pittsburgh, Pa.

Additional bulletins from that company are as follows: Bulletin No. 26 discusses the process of manufac-

ture, properties and specifications; No. 27 quotes from letters relating the experience of practical men; No. 30 is entitled An Investigation of Pipe Corrosion, showing service records of iron, steel and brass pipe used for hot and cold water supply lines in 125 Pittsburgh apartment buildings.

SARCO METALLIC GASKETS are the subject of a new illustrated circular, with list prices, from Sarco Co., Inc., Woolworth Bldg., New York.

DAUM REFILLABLE cartridge fuses for electric light and power are described and illustrated in the latest circular of A. F. Daum, Pittsburgh, Pa.

FROM MAGNOLIA METAL CO., 113-115 Bank St., New York, we have just received a 24-page booklet discussing the origin of Magnolia Anti-Friction Metal, comparison with genuine babbitt, and tests.

DUPLEX DIRECT-CONNECTED, electrically driven air compressors manufactured by Nagle Corliss Engine Works, Erie, Pa., are illustrated and described in that company's Bulletin No. 30.

BOOKLETS have just been issued by Link Belt Co., 39th St. and Stewart Ave., Chicago, as follows: No. 354, "Another Modern Link-Belt Gravel and Sand Producing Plant;" No. 356, "Link-Belt Sanitary Peeling Tables."

Trade Notes

AMES IRON WORKS, of Oswego, N. Y., is arranging for a foundry extension 50 by 250 ft., to give additional facilities for manufacture of Ames Una-Flow Engines.

THE LAMPREY CO., of Westfield, Mass., has recently installed arches for the First National Bank, Soo Bldg., and the Gross Bros. Laundry, at Minneapolis, Minn.; for the Northern Cooperage Co. at St. Paul, Minn., and for the St. Croix Mfg. Co. at Stillwater, Minn.

MARION Machine, Foundry & Supply Co., has taken over the entire business of the Planet Steam Specialty Co., which includes the manufacture of soot blowers for all types of water-tube boilers. The inventor, Gordon C. Bennett, who was also secretary of the Planet Steam Specialty Co., has taken charge of the Engineering Department of the Marion Machine, Foundry & Supply Co., and will develop a complete line of water-tube soot blowers for all types of boilers.

AKERLUND & SEMMES, of New York City, have been receiving a considerable number of orders for their down-draft gas producer for shipment to South America. These orders show the wide application of the producer for different classes of fuel, including sugar cane, refuse and algarroba wood. A 100-hp. producer is to be used with the cane refuse, and 3 producers of 100, 75, and 50 hp. to be used with the wood, all for use in Peru for irrigation purposes. Other installations of 100 and 150 hp. are being installed in several South American countries, and one of 250-hp. with which the fuel used is Brazilian lignite, containing as high as 29 per cent ash and 3 per cent sulphur.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

(Established over 22 years.)

PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

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About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy and cuts should be received at Chicago Office eighteen days prior to date of publication.

Circulation of this issue, 23,100.

Technical Publishing Company

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By engineer experienced with producer gas and oil engines, a.c. and d.c. equipment, pumps, storage batteries, interior wiring and repair work. Technical graduate. References. Address Box 501, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 1-1-1

POSITION WANTED—By young man as oiler in large central station, with 7 years' experience with Corliss engines up to 400 hp., d.c. generator. I. C. S. graduate on complete Steam Engineering. Age 27. Married. Best of reference. Will go any place. Address Box 493, Power Plant Engineering, 537 S. Dearborn St., Chicago. Ill. 1-15-1

POSITION WANTED—As helper or oiler in small or large plant. Will come at once. Sober and industrious. Will consider reasonable salary. Address Box 494, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 1-15-1

POSITION WANTED—By young man as oiler or assistant engineer in or around Chicago, with chance of advancement. Eight years' experience; ready to start work at a week's notice; references. Address Box 492, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 1-15-1

POSITION WANTED—By experienced fireman and engineer who has had charge of waterworks plant, and effected saving of half the coal bill by overhauling the plant. Familiar with electrical work. Address Box 507, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-1.

POSITION WANTED—By middle aged man and chief engineer's license. Can handle D. C. & A. C. machinery, steam boilers, gas and oil engines. Also experienced in wiring and repair work. Address Box 508, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-1

POSITION WANTED—By an engineer with 13 years' experience with boilers, engines, electrical and refrigerating machinery. Wishes to connect with a permanent, reliable concern. Am familiar with flue gas analyzing instruments and furnace efficiency methods. Address Box 509, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-1

POSITION WANTED—Power station draftsman, electrical graduate, experienced in power and substation layout work. Six years in present position with large manufacturing concern. Desires change. Address Box 511, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-1-2

POSITION WANTED—By a practical high- and low-pressure pipe fitter. Age 35 years. Would like to become connected with reliable concern as general pipe fitter or foreman. Address Box 512, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-1-4

POSITION WANTED—As chief engineer. Am familiar with a.c. and d.c. generators and motor ice machinery pumps, simple and compound condenser engines. A1 references. Desire change. Good reason for change. 32 years old. Address Box 513, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-1-1

Help Wanted

WANTED—Resident subscription agents in the following cities; Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

BOILER HOUSE MECHANIC WANTED—A good mechanic, to act as general boiler room repair man in large mill out of town. Must be familiar with machinery, boilers, stokers, etc. State age, married or single, experience and enclose copy of references. Address Box 510, Power Plant Engineering, 537 S. Dearborn St., Chicago. 2-15-3

WANTED—A competent refrigerating engineer in Western Pennsylvania. Must be familiar with raw water and ice making system and electric machinery. State salary wanted. Address Box 505, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf.

WANTED—Agents to call upon engineers to sell positively the best pump valve on the market. Excellent proposition. Big money maker. Address Box 500, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Agents handling engine and boiler room specialties in every section for our Boiler Girth Seam Protector. Liberal inducements. Give experience and territory covered. Address National Boiler Protector Co., Dayton, Ohio. tf.

WANTED—MILL SPECIALTY MANUFACTURER offers an unusual opportunity to a successful, creative salesman to handle the middle western territory from Chicago. Experienced in dealer co-operation and in selling both large and small consumers. Application must be detailed, giving past and present connections and earning ability. Address Box 514, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-1-1

For Sale

FOR SALE—One 306 hp. Double Drum, and one 225 Single Drum Heine Boiler; one Model Stoker for 360-hp. and one for 225-hp. boiler; one 160-hp., and one 100-hp. Tandem Compound Skinner Auto Engine; one Lagonda Tube Cleaner; one Pneumatic Hammer; one 14 in. 54 ft., one 14 in. 45 ft., one 12 in. 53 ft., one 12 in. 45 ft. Double Leather Belts, Endless; two 4-in. Austin, and one 4-in. Cockran Steam Separator; one 8-in. Back Pressure Valve; one Westinghouse Standard 11-in. Air Compressor, Water Jacketed with Tank and Accessories; one 8-in. Oil Separator; one 300-hp. Warren-Webster Exhaust Open Heater; seven 8-in. Gate Valves; one American Water Softener, 1500 gal. per. 24 hrs.; three 4-in. Pop Safety, eight 4-in. Gate, and one 4-in. Angle Valve; one 7-in. Exhaust Head. All this material is in good running order and is in service now. The Busy Bee Candy Kitchen Co., 44 N. Front St., Columbus, Ohio. 3-1-2

FOR SALE—BOILERS. Two 150 hp. H. R. T. Boilers, butt strapped construction, 120-lb. pressure, $1,000 each. 400-hp. Atlas Watertube Boiler with Murphy Stoker and Superheater, built for 210-lb. pressure, 4 years' service, $5,000. Power Machinery Exchange, Inc., Jersey City, N. J. tf.

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St. N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

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FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

FACTORY MANAGERS, ENGINEERS AND OWNERS—Coal is high and scarce. Let us tell you how to conserve it and utilize your exhaust steam for heating and drying purposes. Address Monash Engineering Co., 1413 W. Jackson Boulevard, Chicago, Ill. tf.

Sparks From The Advertising Pages

Where Buyers and Sellers Meet

Laying A Safe Course

Every sea-going vessel has what is called a chart room.

Here are kept the charts by which the navigator "lays his course"; here in long tin cylinders not unlike the cases in which engineers and architects enclose their blue prints, are to be found charts of the Coast and Geodetic Survey and of the Hydrographic Office of the Navy.

They indicate in detail off-shore soundings, principal lights, outer buoys and landmarks and they are essential to the navigator in fixing his position as he approaches shore from the open sea or coasts between distant ports.

A chart, to be valuable, must be up to date. Lights may be changed, bars may shift, new rocks and shoals discovered, different fog signals installed.

Through various pamphlets, notably the "Notice to Mariners," published periodically by Government Bureaus, the careful navigator keeps apprised of every change made to aid navigation.

With this information before him he frequently corrects his charts and keeps them reliable; and he is thus able to bring his ship confidently, safely and speedily to port.

He wastes no time laying courses which he must retrace, he runs no risk from hidden shoals or treacherous reefs, when he follows his chart.

In running the power plant smoothly and wisely through the troubled waters of present conditions, what a satisfaction to the power plant navigator it is, to know that he, too, has in POWER PLANT ENGINEERING a chart which enables him to steer a safe and successful course!

In this parallel, the advertising pages of POWER PLANT ENGINEERING may be likened to the "Notice to Mariners" by which you are kept posted of changes, of betterments, of developments affecting your work.

Lay your buying course by referring first to the advertisements in POWER PLANT ENGINEERING and you need have no fear of the outcome. It has "sounded" every proposition offered here and knows that it is truthfully charted.

You can accept the statements of POWER PLANT ENGINEERING advertisers as unquestionably as the navigator accepts the reports of the Coast and Geodetic Survey. There are no snags in buying through this channel.